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# MACHINERY:

VOL. 1. No. 10. PUBLICATION OFFICE: 411-413 PEARL STREET, NEW YORK CITY. JUNE: 1895.

A PRACTICAL JOURNAL FOR MACHINISTS AND ENGINEERS AND FOR ALL WHO ARE INTERESTED IN MACHINERY:

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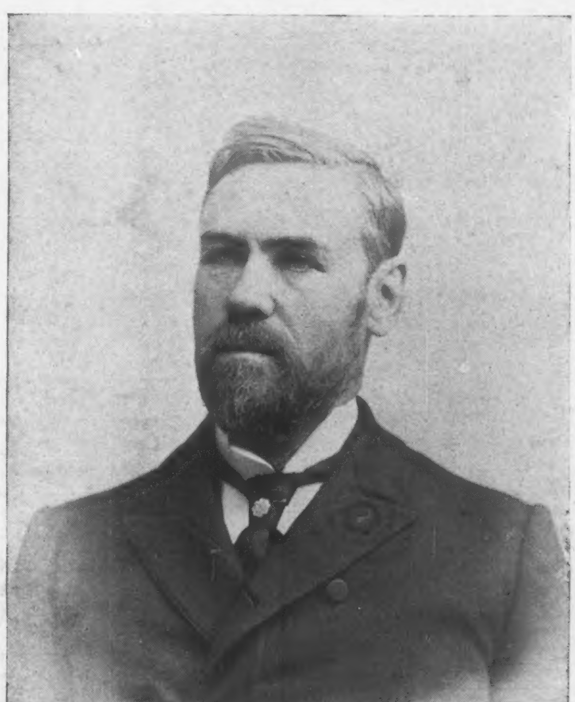

R. C. Carpenter

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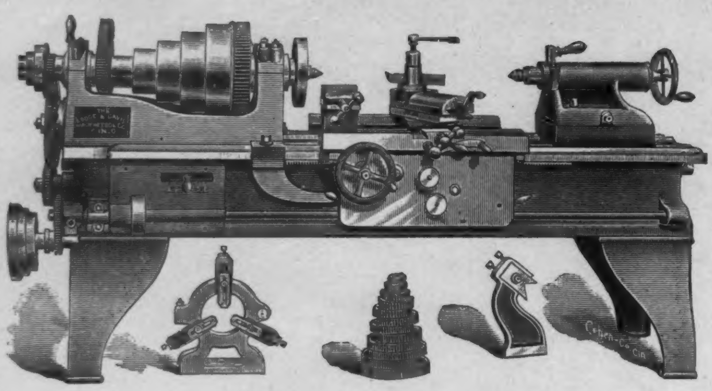

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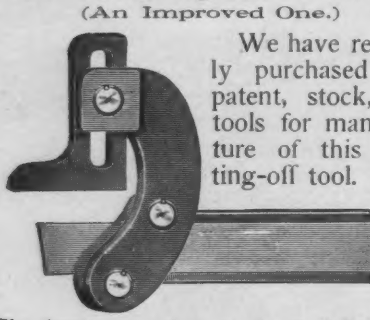

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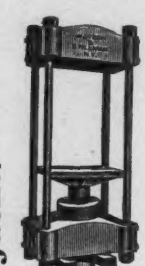

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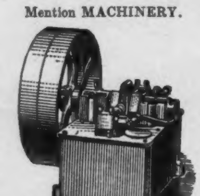

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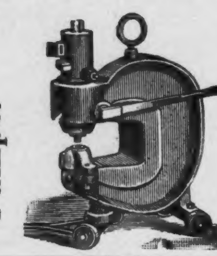

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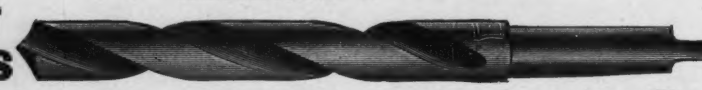

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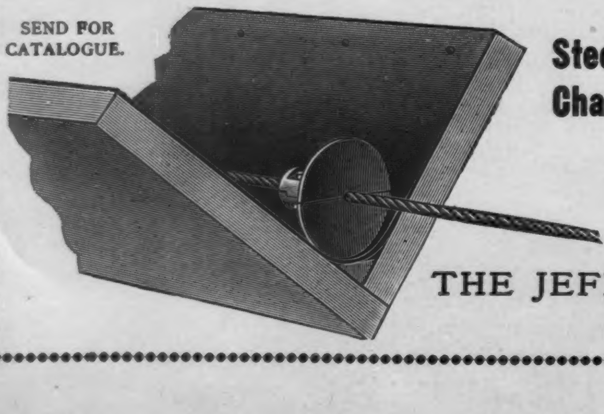

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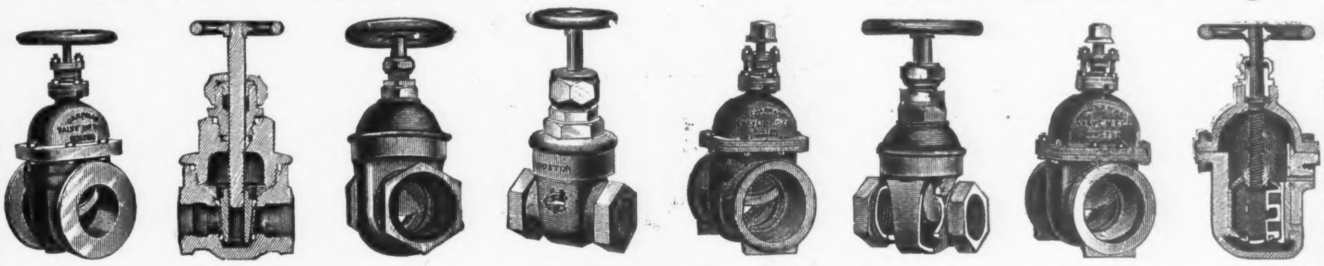

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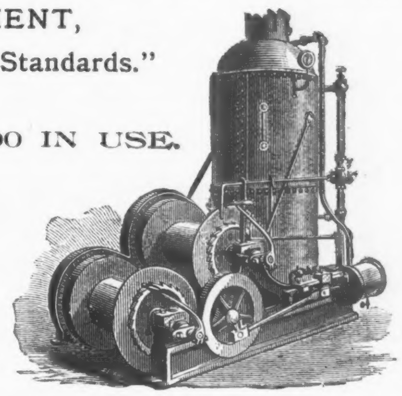

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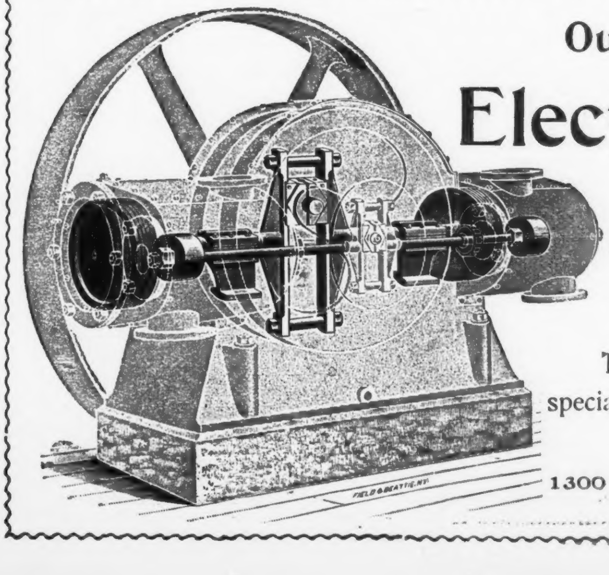

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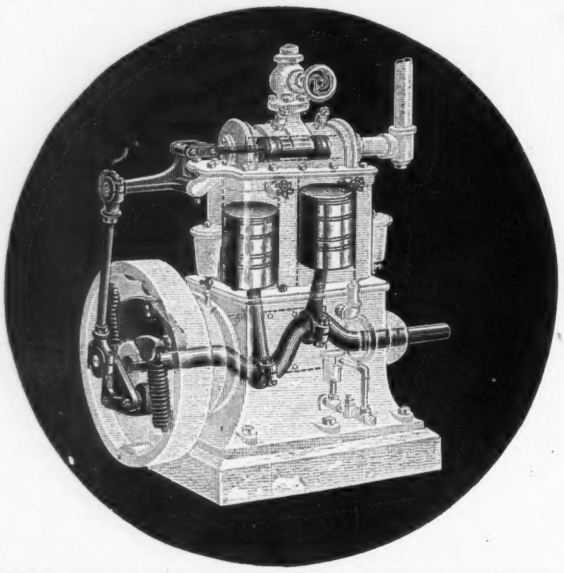

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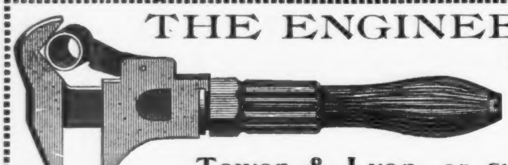

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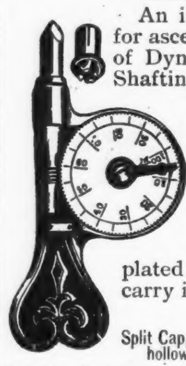

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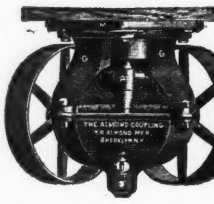


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# Use RIEHLE TESTING MACHINES

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CONSULT THE INDEX ON PAGE 6.

CONSULT THE INDEX ON PAGE 5.

# MACHINERY.

VOL. I. June, 1895. No. 10.


## WASTES FROM BOILER MANAGEMENT.


R. C. CARPENTER.


THE writer's attention has been frequently called during the past year to the fact that the usual system of boiler management as practiced in steam plants is accompanied with great waste, and further, that comparatively little attention is paid to the matter. The economy of the steam-engine itself has been and is a matter of serious consideration; the best designers in the country have carefully studied the problem, and the best workmen, aided by excellent tools, have executed these designs in the most careful manner. Every change in valve motion or in detail of construction that would insure the saving of even ½ per cent. of the consumption of steam has been the subject of the most careful consideration. The changes in the steam-engine, while they have tended constantly to increase its economical performance, have done so only by gradual improvements, and in every case when saving has been produced, it has been small in amount. Comparing the steam-engine with the ideal which it cannot possibly surpass, and it will be readily seen that the greatest possible improvement which can be made will not give a very great increase in economy. Indeed, it seems quite possible that we must look for lines of improvement principally in the direction of increase in steam pressure and greater range of expansion, which in turn will probably signify an increase in the number of cylinders of the engine. The principal difficulty connected with the use of high pressure steam to-day is due to its production,* and will be found in the construction of a proper boiler and furnace for producing it economically. While there are many engines in use to-day of an economical type, and not working to advantage either for the owner or the manufacturer, yet I am quite certain that the number of such engines is far exceeded by wasteful boiler plants. This is true to such an extent that I think it not entirely unjust to say that the designing engineers of the country, in their anxiety to save 1 or 2 per cent. by improving the steam-engine, may have neglected the waste of 8 or 10 per cent. in either the construction or operation of the boiler.

The wastes which characterize the operation of the boiler consist of first, the heat discharged in the flue; second, that lost in radiation and in heating up the air of the boiler-room; third, that which is lost by heat carried off in the ashes by unburned coal and by imperfect combustion. The amount of heat lost in the flue is in part utilized in producing draft when other means are not at hand, but it seems quite probable that the amount discharged is altogether in excess of that required for draft, and is vastly greater than would be required to produce the draft by mechanical means. There is also another loss which may be considered as secondary to that in the flue and possibly is one of the causes of flue loss, and that is the introduction of a great excess of air into the furnace. The introduction of a large body of air tends to lower the temperature in the furnace materially; thus, for instance, were the coal to be burned with simply air enough to maintain perfect combustion, we might have a maximum temperature of 4,456 deg. Fahr. When the excess of air is 50 per cent. over that required for perfect combustion the maximum temperature becomes 3,515 deg. Fahr. When the excess is 100 per cent., the maximum temperature is 2,110 deg. Fahr. When the excess of air is 150 per cent. over that required, the maximum possible temperature is about 2,200 deg. Fahr.

The amount of air required for the perfect combustion of pure carbon is practically 12.5 pounds, the volume of which at ordinary barometric pressures and temperatures is about 150 cubic feet. Now it is a very common thing to find that boilers are using from 25 to 30 pounds of air for each pound of coal consumed, hence the temperature of the furnace must and is of necessity very low.

The effect of a low temperature in the furnace is to reduce the absorbing power of the surfaces of the boilers. This absorbing power increases with increase in difference in temperature, and at a much faster rate than the difference of temperature. The efficiency of the boiler depends entirely upon the power of absorbing heat from the heated gases on one side through the metallic walls of the boiler by the water or steam, and also by the power of the boiler to absorb directly the rays of radiant heat coming from the fire. If we have a high temperature in the furnace and of the gases passing through the furnace, the power of absorption is very much increased, and a greater portion of the heat will be utilized in producing steam.

The fact that high temperature does not necessarily mean an increase in the quantity of heat should be noted. A large body of air at a comparatively low temperature might carry out a very great quantity of heat as compared with a small body of air at a high temperature. The activity of the heat and its useful qualities depend largely upon its temperature, and the fire should be managed so as to be kept at as high a temperature as possible consistent with perfect combustion.

Following this course of reasoning through, one of the requisites of economy that is required is high temperature in the furnace. This on the other hand means a small supply of air, but an amount which is sufficient to support combustion. To secure perfect combustion with a small amount of air requires an intimate distribution of the air and fuel. This of necessity requires a strong draft which possibly can be more cheaply produced by mechanical means than by heating the chimney.

* Since the above was written, a quadruple expansion engine, built by Hall and Trot, two graduate students in Sibley College has produced a horse power of work with less than ten pounds of steam per hour, using steam at a pressure of 500 pounds above the atmosphere.

The amount of chimney waste no doubt varies very greatly in different plants. In a test made by the writer of the engine at the Milwaukee pumping station, the heat carried off in the flue was 10.8 per cent. of the total from the coal. In a test of the Worthington pumping engine at Hampton, England, Prof. Unwin found the loss in the flue as much as 10 per cent. And in the recent test of some Manning boilers, by Prof. Denton, the loss in the flue was found to be 13.04. In the first case mentioned above, the loss of 10 per cent. meant the loss of at least 55 H. P. of work. That is, the engines developed 550 H. P. from the heat in steam, which represented 76 per cent of that in the coal. The mechanical work done in this case by the draft represented only a small part of the loss of power due to the escape of heat in the chimney. This will be evident from the following calculation: In that test there was supplied 18.9 pounds of air per pound of coal, 759.7 pounds of coal per hour, or a total of 239.27 pound so fair per minute. As the temperature of the chimney was 406 deg. Fahr., and as at this temperature and pressure 22 cubic feet exist per pound, we have 87.7 cubic feet passing through the chimney per second. The area of chimney being 38.5 square feet, the velocity must have been 136.7 feet per minute, and hence would represent mechanical work equivalent to .995 H. P. This would indicate that for that plant at least, a gain of a good many horse power would have been possible by the substitution of mechanical for natural draft, provided the heat discharged from the flue could have been prevented and utilized. It is quite possible with mechanical draft and with an economizer in the chimney to reduce this loss fully or quite one half. In the test at Milwaukee, the heat lost by radiation varied from 6 to 9 per cent., and this loss exercised no useful function, and was very much larger than was necessary. The other losses varied from 7 to 12 per cent., depending on the firemen, and were such as might have been entirely obviated under the best conditions of boiler and of management. It would seem from these considerations that an expenditure of 5 to 10 per cent. for the draft might be an economical use of the heat, but that all further losses in the boiler-room do not in any way assist in evaporation, and are consequently wasteful from every standpoint. Calling the heat value of the coal consumed 100, the percentage which is converted into steam very seldom reaches 80 per cent., even does not often reach 75 per cent., usually is from 60 to 70 per cent., and sometimes as low as 50 per cent. The loss from radiation might in some cases reach 10 or 15 per cent., it would be likely to be very high if the boiler were exposed to cold winds or to a low temperature generally. The great loss, however, is found usually in the unburned coal carried off in the ashes. An inspection of the ash pile which is thrown out from the boilers in most plants will enable one to judge quite accurately as to the amount of one of the greatest losses which take place in the operation of steam plants. The actual amount of ash found in our coals seldom exceeds 10 per cent., but the amount of refuse carried out from under our boilers very rarely falls short of 16 per cent., and indicates a useless loss which on the average, is probably more than 6 per cent. of the total coal bill. Now this is a loss which the fireman is largely responsible for. There are of course certain plants erected under such conditions or operated in such a manner that a large waste of fuel is inevitable, but in the great majority of cases the exercise of intelligent care and discretion on the part of the fireman would save a large portion of the loss referred to. How far the fireman is responsible for other losses is also one which is difficult to answer in a general way, but it is quite certain that in nearly every case the difference between good and bad firing means more than 10 per cent., and often as high as 15 per cent., in the coal bill. In a case which came to the writer's notice, the difference in results obtained on the same boiler under the same conditions and by men both considered experts in their calling, was fully 9 per cent. What the difference in result between the work of a good fireman and a poor fireman might produce, the writer can only conjecture, but it would probably be not less than twice that amount. Ten per cent. of the amount expended for fuel is usually many times the wages paid to firemen, and it is a question open to the most careful consideration whether it would not be to the interests of the employer to pay large wages and even offer premiums to induce the most economical management of the boiler plant.* The operation of firing is usually considered one which any man can easily perform and as requiring very little intelligence. As a matter of fact the fireman is entrusted with the management of the most responsible part of the plant, and with the expenditure of the largest portion of operating expense. The boiler badly managed soon becomes dirty and dangerous, while the fuel bill becomes unnecessarily large and the waste of coal enormous. On the other hand, an intelligent and skilled fireman may save to the owners many times the amount expended in wages as compared with one who is ignorant and careless.

The fact is one to be considered, however, that the larger portion of our plants are converting only about 60 per cent. of the heat in the fuel into its equivalent in steam, while it is entirely possible with the best arrangement of plant and best management to raise this amount to 80 per cent., thus making a net saving of 20 per cent. This means that one ton out of five of coal consumed does no useful work, but in addition causes an expenditure of labor and money for handling it and for removing the refuse created by its combustion.

The loss is one which can be prevented either by improving the boiler plant or by improving the management of the fire room. The latter is in general the most important, for it is quite certain that no improvement made will result beneficially without an intelligent management of the boiler and its accessories.

* * *

* The writer has recently been informed that a system exists in Germany of this nature; the fireman being paid in proportion to the $(CO_2)$ carbonic acid found in the flue; the amount being determined by frequent and systematic analyses.

## MACHINISTS' CLUBS.

THOMAS P PEMBERTON.

The tendency of the times is centripetal. It is influencing production and distribution—industries of all sorts—and the movement of populations. It may be considered as a new evolution of civilization, the beginning of a higher organization of society, made possible by steam and electricity and the higher development of the individual. Co-operation and concentration are observable in all political, educational and religious organizations, and from strong centers radiate a distribution of activities and a promulgation of ideas and principles that are far reaching and influential.

As an illustration, we can point to labor and trade organizations, engineers' associations, to mechanics' unions, to societies of all classes which have special objects in view, and a headquarters from which a general supervision is maintained over the different branches and subordinate lodges. The main objects of these are known to be social intercourse, the cultivation of fraternal intercourse, education and financial assistance in time of need, all of which are laudable and desirable objects, and of especial benefit to tradesmen and workmen. The success and usefulness of these organizations depend very largely on management. It is too often that weakness and indifference are the natural results of incompetency, erroneous judgment and lack of energy on the part of officials. On the other hand the most successful and strongest societies are those which have the right men in the right place—those who know men and possess tact and judgment.

With these preliminary remarks I call attention to machinists' clubs.

A machinists' club is a thoroughly practicable association that can be organized and maintained at any extensive iron works. A large, comfortable room or small hall, the former is preferable, can be obtained in any manufacturing town or city. It should be carpeted and well equipped with comfortable furniture, consisting principally of arm-chairs, tables and desks, book-case, cabinets, lecture stand, etc. To these may be added piano, books, magazines, industrial publications, charts, models and

pictures. This room should be open in the evenings from seven until ten o'clock for the use of members. Coffee and light refreshments might be served at nine o'clock. One evening in the week should be devoted to the reading of papers, discussion, lectures and entertainments. Altogether the club-room should be an attractive, interesting, comfortable resort for educational and social purposes, specially appropriate for use by a machinists' club. The membership should not exceed one or two hundred, and be confined to those machinists employed at the works. The income can be approximately reckoned as follows:

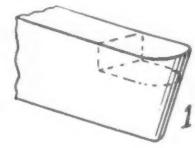
| | |
|---|---|
| 200 members at $3.00 (initiatory) | $600.00 |
| 200 monthly dues at 25 cents | 50.00 |
| Outside admissions to entertainments | 25.00 |
| | $675 00 |

The initiatory fees and monthly dues should entitle the member to all the privileges of the club. The entire management should be in the hands of four officers, namely, president, treasurer, secretary and superintendent. All details would be suggested by circumstances. Such clubs could be developed as a means of much usefulness and interest in every community where there are machine works.

* * *

## AMONG THE SHOPS.

The firm of Detrick & Harvey, Baltimore, Md., will probably always be thought of in connection with the "open side planer," as they have been so closely identified with its improvement and introduction in this country. The first impression is that the design is necessarily weak, and using the same amount of metal that if found in a two-post (or ordinary) planer, the tool would not be very firmly supported at the outer end of the beam. But by careful design and a generous supply of metal these tools will take heavy cuts with any planer of their size, and have a much wider range of work than the ordinary, making them especially useful for general machine work. An idea of the capacity of one of these machines may be had from the accompanying photograph, which shows one of their regular shop planers at work on the post for another planer, much larger than the working one, as seen by the dimensions and weights given. These also give an idea of the metal put into these machines to make them capable of doing the heavy work which is required of them. This affords the best idea of the possibilities of the work of an open-side planer the writer has ever seen presented. Being interested in modern practice in speeds, feeds and depths of cuts, inquiries were made in most shops visited with the result of finding a material increase in speed commonly used a few years ago. The cutting speed here ranges from 20 to 25 feet per minute on cast iron, and the latter is a regular speed with these planers in many places, with a return speed of table of from 3 to 5 to 1. From cutting speeds to tools used is an easy step and both are interesting and important. In the sketches, tools No. 1 may be called the "Philadelphia" tool, No. 2 an improvement on it, although some do not consider it as such, and No. 3 a "Dutch nose"—at least these names will answer, though they may not be technically correct. No. 1 is a Philadelphia favorite for "taking" (I can hardly say cutting) off stock, and for hard cast iron it may stand better than the others, although if they are made with as little rake, *i. e.*, the cutting edge as well supported, there is no reason why Figs. 2 and 3 should not stand as well, and as they give a shearing cut the writer prefers them after being brought up on the Philadelphia style. A great many shops are using No. 2, which is very little different in action from No. 3, but somewhat more expensive to make. No. 3 gives good satisfaction, will stand all the lathe or planer will, and by grinding quite a sharp bevel, will give an easy shearing cut, which is very different from the tearing action of No. 1. I expect to be disputed in this respect by many who have never used the "Dutch nose" tool or whose experience may not have been as favorable as mine, but think I can make as strong a case *for* this tool as others can *against* it.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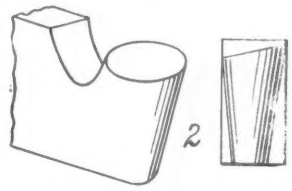
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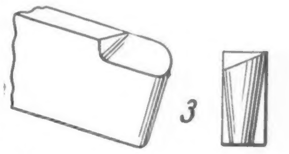
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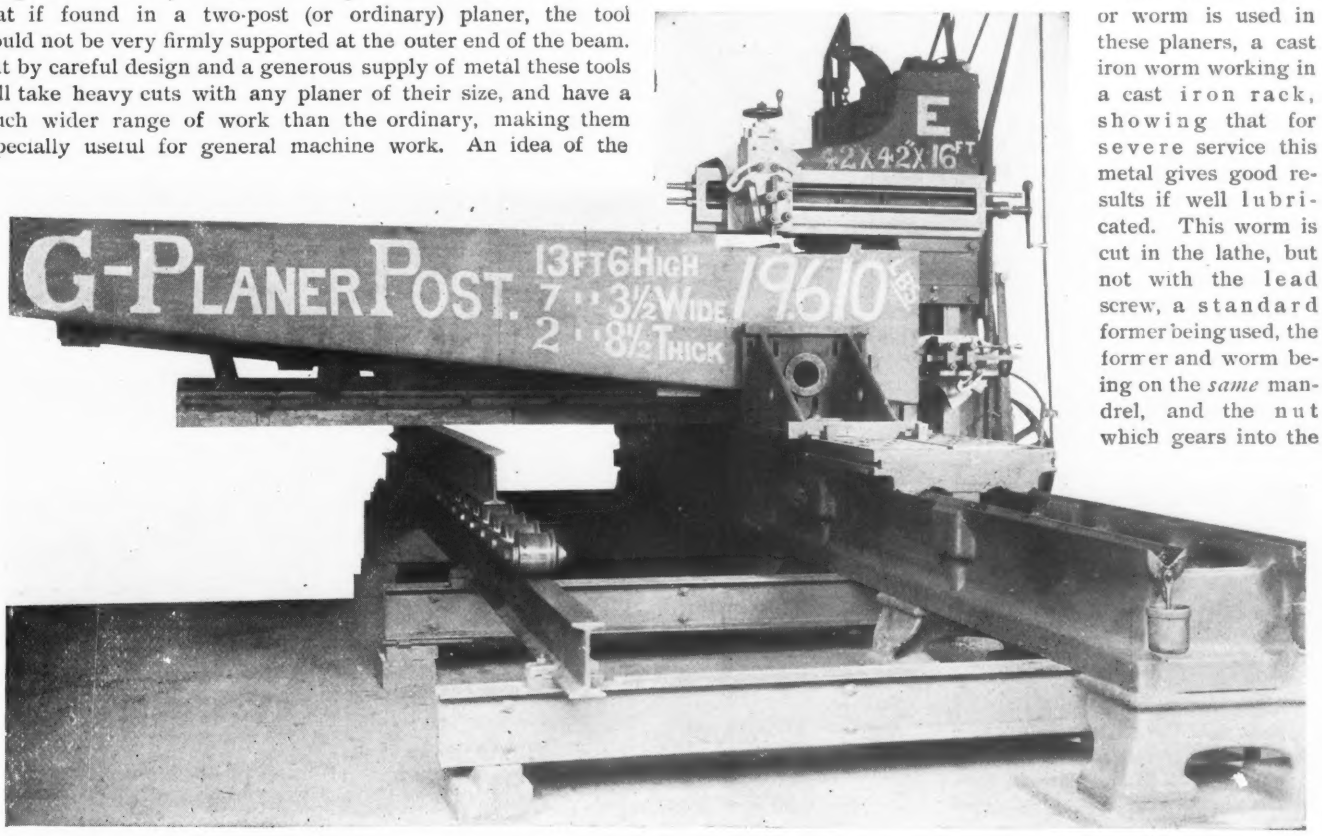
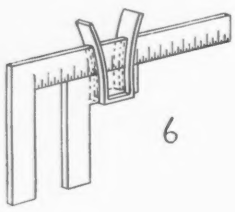
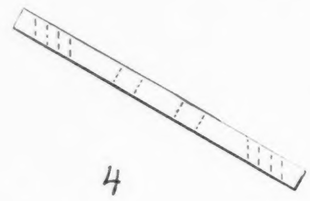


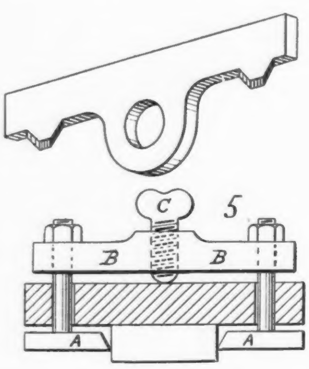

The Sellers screw or worm is used in these planers, a cast iron worm working in a cast iron rack, showing that for severe service this metal gives good results if well lubricated. This worm is cut in the lathe, but not with the lead screw, a standard former being used, the former and worm being on the *same* mandrel, and the nut which gears into the former being *fast* to the carriage which carries the tool for chasing, insuring a worm as correct as the former, which was cut accurately.

Those familiar with this type of driving gear will appreciate the device shown at Fig. 4 for supporting the bar used to face and bore the bearing in the worm pocket. This fits on top of the Vs of the planer, the center projection extends into the pocket and is adjustable up and down, and the bar is well supported by the bearing hole shown. The bed of the boring mill where these are bored is laid off to the correct angles for each size, holes are drilled for pins which locate a straight edge on the top of the bed, and it is an easy matter to set any bed exactly right for boring, the directions necessary being painted on the frame of the mill, so there is no excuse for forgetting, which is expensive to all concerned. Bolt threading machinery forms quite a share of the business here, and machines for heavy work are turned out, bolts up to 6 inches being threaded for bridge and other work. In this connection it is interesting to note a remark of Mr. Easby, the

superintendent of the works, regarding the accuracy required in having the cutting dies or thread-cutting portions exactly in line to produce good work. The die holders may be likened to the jaws of a chuck working (to and from the center) in a suitable body. The slots which hold the cutters must be exactly at right angles to the spindle (or axis of revolution), or a poor thread results when the cutters are adjusted in either direction from the size at which the cutters were hobbed. The slightest error shows in this work, and the thickness of tissue paper "out of square" will make itself known in the work. A very handy chuck or holder for thin pieces to be ground on the face is shown in Fig. 5. It needs little explanation, the jaws A A are connected by bolts to the straps B, which carries the thumb-screw C bearing on the




back of body and drawing the jaws toward it, clamping any piece of suitable size sufficiently firm for the grinding required. Another handy tool used quite extensively here is a beam caliper made of sheet steel and locked by the clamp shown in Fig. 6, which, though not entirely new, is not widely known, and is very handy indeed. Pressing the projecting ends together releases the jaw, which locks as soon as released. Made with fair accuracy and without graduations, they form a cheap and handy tool for lathe or similar use.

The use of the milling machine is widening here as elsewhere, and month by month its uses are becoming better appreciated. Standard milling cutters are grouped for special work, and these combinations are being constantly increased, showing that their use is being sanctioned as good practice for much work even in the home of its supposed enemy—the planer—and also showing that each has its field of usefulness in the different classes of work in the shop, the field of the miller, however, being constantly widened, so that the hopes of our friends John J. Grant and Horace L. Arnold may both be realized in the not too distant future.

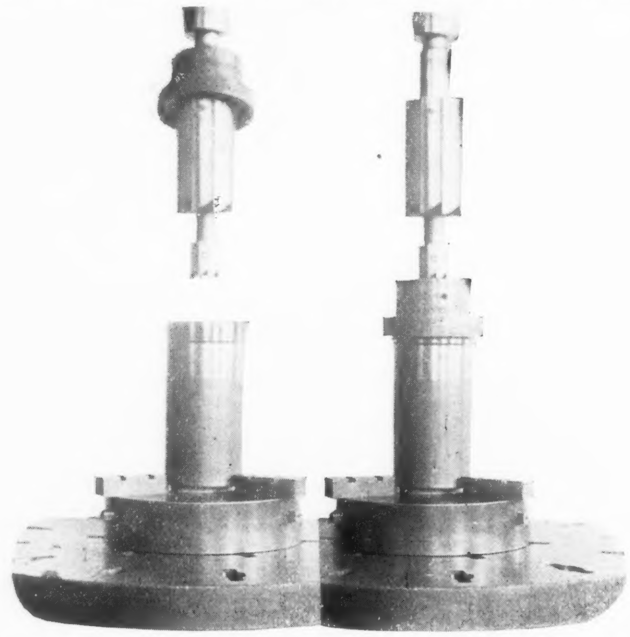
## BORING AND REAMING TOOLS

The problem of accurate work has many phases, but few more common or more difficult than those of boring, facing and reaming holes accurately, at moderate or minimum cost. The shape and design of the cutting tool have much to do with the results obtained, and in no case that the writer knows of is this better exemplified than in the shop of Mr. T. R. Almond, Brooklyn, N. Y., whose high grade work on his angle couplings is generally credited as being the real reason of their commercial success. This is in nowise exaggerated, as there is little doubt that a lower grade of work would result in poor service, if not failure, in this as in many other cases. Boring large holes in a cored casting is not an easy task, particularly if accuracy is required, and yet by Mr. Almond's method no difficulty is experienced, and as it may help others on similar work it is given for the benefit of mechanics generally. The half-tone shows a sleeve being bored on a drill press, and while the tools do not appear extraordinary in the least, they are very interesting in several ways.

The work is held in a three-jawed chuck, gripped "short," *i. e.*, a disc of wood placed between the work and chuck to prevent cramping in the chuck, then the guide or sleeve shown (which is bored to fit the work and also the reamer) is placed over the work and the reamer started. This seems very ordinary, but not so with the details or the results. The cutters are made as shown, but kept ground *perfectly square* on the points, and the guide is made about a thousandth of an inch larger than the reamer, to allow for clearance, and is the key to success in using these fixtures. Mr. Almond has discovered and proved that within reasonable limits, say ten thousandths of an inch, the hole bored will be the size of the *hole in the sleeve* and not the size of the reamer, and by giving the guide or sleeve this small amount of clearance it gives the cutter the same clearance in the work and prevents binding and unduly heating the reamer. The guide fits easily over the work and is held firmly until cutter has fairly entered, say $\frac{1}{16}$ inch, centering the cutter as well as governing the size of the hole.

After starting the cutter the sleeve is raised as shown, a small pin holding it above the upper cutter, and the tool keeps at work until the two holes are bored exactly in line and finished at one cut. The bottom of the large hole, or shoulder, is roughed out in the lathe before boring, simply to save the cutter and lengthen its life, and while it makes a little extra work, it is more than saved in the life of the tools.

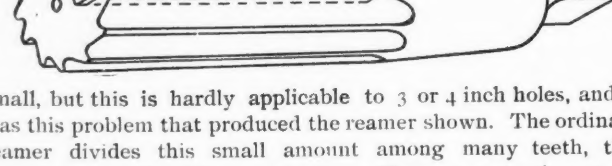
Analyzing the action of the tool a little we find that with the square cutting-point it has a tendency to "wander" within the limits of the sleeve, which accounts for the hole being the same size as the sleeve, within limits, as mentioned before. With a



convex point the tendency is to center itself, bind and wear away the cutting-edge, producing unsatisfactory results. Some of the reamers shown the writer, on the same plan as these illustrated, have been in use about six years and are doing accurate work to-day, something quite remarkable to one accustomed to ordinary methods employed in work of this character.

This emphasizes the writer's experience with boring tools regarding the necessity of grinding on the face and keeping the edge or point square so that all cutting is done on the end only, but the feature of the guiding sleeve being slightly larger and governing the size of the hole, is believed to be new to the great majority of mechanics.

There is much of interest in this shop which will be dealt with later, but in this connection a reamer patented by Mr. Almond some years ago is interesting. Every mechanic knows the difficulty encountered in finding a reamed hole "just a trifle too small," it may not be over half a thousandth, but it is enough to prevent the shaft from fitting as it should, and how to remove the remaining metal is a serious question. In a recent issue "A. Learner' told of driving a solid plug through holes slightly



small, but this is hardly applicable to 3 or 4 inch holes, and it was this problem that produced the reamer shown. The ordinary reamer divides this small amount among many teeth, this one does it all with one tooth. There are teeth cut as shown, but the single inserted tooth is really what does the work, the others having little to do but guide and keep the main tooth up to its work. The slot for this tooth is of course

The artist has not shown the adjustable bearing in Fig. 4, nor the complete chuck in Fig. 5, but each give the idea.

tapered so that driving it back toward the shank increases the diameter. Simple as this tool appears, it works very satisfactorily indeed, and is one of the many cases where good tools have been invented, patented and never pushed into the prominence their worth deserves. This article refers solely to boring cast-iron.

* * * F. H. C.

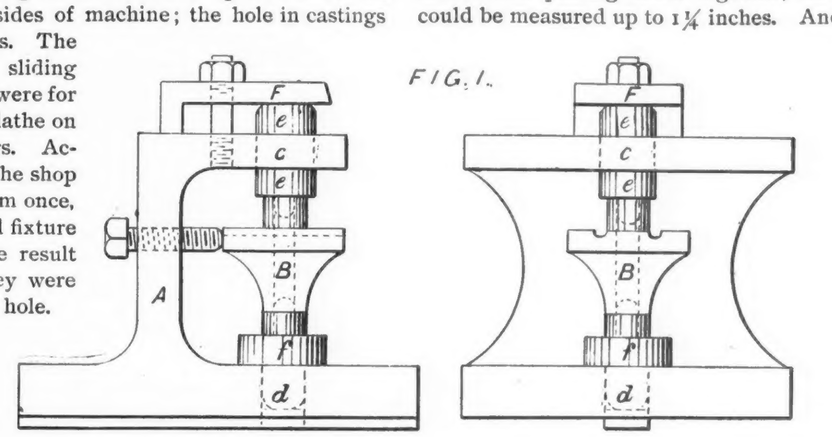
## SHOP TOOLS.

J. T. G.

The tools which I am about to describe I have used in a machine shop and found to give good service, and I think they may be of interest to some of the readers of MACHINERY, as they might be used to advantage on various kinds of work.

Fig. 1 is a sketch of a fixture A for milling the lugs on a casting B. Two of these castings were required for a machine; they were to cause a table to reciprocate vertically, the table being screwed to the lugs, which were faced off square with the hole in casting. The castings and table slid up and down on two upright shafts on the sides of machine; the hole in castings being a sliding fit on shafts. The lugs on this casting or sliding bracket (we might call it) were for a long time trued up in a lathe on an arbor between centers. According to an old hand in the shop they attempted to mill them once, but as there was no special fixture made for the purpose the result was unsatisfactory, as they were not milled square with the hole.

FIG. 1.




The fixture A was planed top and bottom, with tongue in bottom to fit milling machine table. It was then drilled and bored with boring-bar for two holes *c* and *d*, to which plugs *e* and *f* were fitted, the bottom plug being forced in the fixture to abut on a shoulder, and the top plug being a sliding fit in hole *c* had the end turned down to fit hole in sliding bracket. A stud was screwed in the fixture and a strap F was used to screw down plug *e*, thus clamping the casting B between, the two plugs *e* and *f* holding it vertically. A set screw was used which screwed through the fixture A to take the thrust of the cutter against the work. This device did the work satisfactorily in a little less than one-third of the time consumed in doing the job in a lathe.

FIG. 2

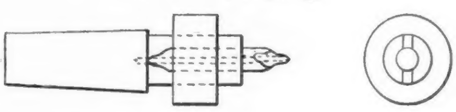


FIG. 3.

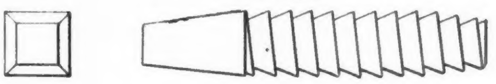


FIG. 6.

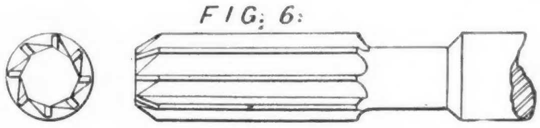


FIG. 7.

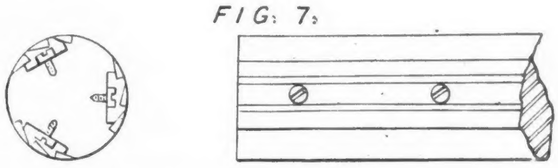


Fig. 2 shows a handy form of chuck for a centering machine. The taper shank fits in the drill spindle and the other end was turned to fit a taper collar. It was drilled to fit a combined drill and countersink and then slotted with a milling cutter, so that by driving up the collar the chuck closes on the drill and binds it. The advantage of this method of centering work is that it centers, drills and countersinks the work at one operation, and gets the center hole true with the countersink, so that if it is necessary to square up the work after being turned it still runs about true.

Fig. 3 represents a broach for enlarging square holes in cast iron, to be driven through with a hammer. The hole in the iron was cored out and the broach was to make it parallel and of size to fit a square bar. The stock for the broach was first planed square and to size in a shaper, then planed tapering at both ends. The vise of the shaper was then swiveled at an angle so that the teeth would be planed diagonally and have a shearing cut. A grooving tool was used to plane teeth, about one-eighth of an inch wide, the cutting edge being ground at a slight angle so as to back off teeth of broach. The broach was then filed and hardened. It kept its size for a good many holes, and the saving of time and files was considerable.

Fig. 4 is a sketch of two hardened steel size blocks, which were planed and lapped to size and stamped with their respective sizes on the faces, so that when the numbers are up, and the blocks used on a planer to set the height of planer tool, there will be no liability of getting the wrong size by mistake. A set of these blocks are very useful in a machine shop, either on a planer or lathe, or for measuring distances where neither scales, calipers or surface gauge could be satisfactorily used. Their use saves a good deal of time, and a workman can do better work with than without them. By making blocks of $\frac{1}{32}$, $\frac{1}{16}$, $\frac{3}{32}$, $\frac{1}{8}$, $\frac{5}{16}$ and $\frac{5}{8}$ inches and putting them together, all sizes in thirty-seconds could be measured up to $1\frac{1}{4}$ inches. And blocks of .05, .1, .2, .3 and .4 inches would measure sizes by tenths and half tenths up to one inch. If blocks as small as $\frac{1}{32}$ inch and .05 inch are hardened they should be quenched in oil. In making these blocks they could be planed about .005 inch large, then stamped with sizes, and if there is no surface grinder they could be lapped with dry fine emery on a planed cast iron surface, to within about .002 inch of the required size, then hardened and lapped to size. In measuring these the micrometer should be occasionally tested and adjusted when worn.

FIG. 4.

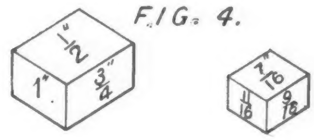


FIG. 5.

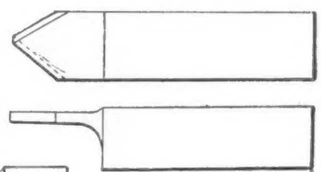


Fig. 5 represents a drill tool to be used in a lathe before starting to drill a hole in solid metal. With this tool clamped in the tool post the end of work can be trued up about the size of drill, and the drill following will usually start true. If a twist drill starts true, long holes can usually be drilled straight enough for most purposes, using a machine reamer to get the work smooth. The drill or reamer can be forced through by the tail-block center of lathe, with a dog screwed on shank, with tail towards the work, and a bar between tail of dog and tool, the bar resting on lathe carriage or shears. The machine reamer (Fig. 6) is used to get a hole the right size for the hand reamer to follow. In shops where machine reamers are not used, twist drills or the common flat chuck drills are depended on, and the time used in calipering and grinding these drills so as to have them the right size for the hand reamer to follow, would pay for a set of machine reamers in a short time if much chucking was done, and usually too much or not enough will be left for the hand reamer; if too much is left a tapering hole will result unless a jig is used to guide the reamer. Sometimes when there are no machine reamers the hand reamers are in use in the lathe, which soon destroys them for good service.

The machine reamer (Fig. 6) could be made about .004 inch smaller than the hand reamer, and should taper slightly, about .002 inch smaller at the back than at the cutting edges. For iron and steel it is not necessary to back off the teeth lengthwise as in a hand reamer, as it is only necessary to have it cut on the

beveled end; but for brass work it is essential so as to prevent the reamer from binding in hole.

Some mechanics prefer a solid hand reamer and others an adjustable one, but if solid reamers are used in a shop special reamers should be kept for reaming brass, as it is necessary that such reamers should be quite sharp and have more clearance than for iron and steel. But if only one set of reamers are provided for reaming all kinds of metal, it is best that they should be adjustable, and a set of plug and ring gauges provided to adjust them to and to try in the work. A set of such gauges are very convenient for workmen to set calipers to when turning in the lathe.

A convenient form of adjustable reamer is shown in Fig. 7. Three slots equally spaced are milled or planed in the body of reamer, and rectangular pieces of steel fitted to them and screwed down by small machine screws. They are then turned enough larger in diameter to allow for grinding after being hardened. The bottom of the blades are then ground straight and screwed to their places and ground to within about .002 inch of the finish size, and then oilstoned to size. In oilstoning the teeth on a reamer the best results are obtained by using strips of oilstone in the same manner as in filing, the oilstone being used as a very fine file, and care should be taken to leave the cutting edges of the teeth the highest. When the teeth wear down the size can be restored by placing strips of paper in the slots. For sizes below ⅝ inch this form of reamer would not be very well adapted, as the groves weaken the stock, allowing it to spring.

Sometimes it is necessary for machinists to devise ways of working which are out of the ordinary. A ⅝ solid reamer was to be made at once, and the milling machine (which was the only tool around the shop which could do indexing) could not be spared, so the following was resorted to in order to flute the reamer in a lathe: A side tool, such as is used for squaring to the center of a piece of work, was ground with the clearance desired, and the top edge set level with the lathe center; the spindle gear was divided by counting the teeth and marked with chalk; the flutes were cut by traversing the lathe carriage back and forth by hand and indexing by the spindle gear. The square on the shank of reamer was divided in this manner with a pointer tool. This is a good way to draw the lines for a half-round taper reamer, but the centers of the lathe should be set straight before marking the lines or the reamer will not be equally divided.

In cutting V threads in the lathe, a certain distance on the work, where a grove to the bottom of thread is not allowable, it is a good plan to take a three-cornered file and file on the same inclination as thread a place about the depth of thread for the tool to run into; this will help to prevent the point of tool from breaking off, which is so annoying when cutting threads on tool steel.

* * *

## THE BOSS AND THE MAN WHO WORKED BY THE PIECE.

A friend of mind is boss of a shop; no matter where. He made a contract for certain machinery, and let some of the parts out to the men by piece work, and made a price on a certain piece of $3.00; after a while he found the man was "making too much" and cut the price of this piece to $2.50 and later to $2.25; in spite of this the man continued to make good wages, and the price was by successive cuts finally reduced to $1.35, at which the man is now making what the boss thinks is about the right amount of wages. My friend, the boss, wants me to "write up" this man whom he thinks didn't treat him fair, because he didn't sail in and make all he could at first and let the price be cut from $3.00 to $1.35 at one slap, and thus save bookkeeping, etc. He thinks the man wasn't quite honest to "nurse his job" in any such way, and that the man was taking advantage of the Company, and wants me to "write him up." Well, here goes, and I hope my friend will not regret his request, but I am "harassed with doubts" as Mark Twain said:

I suppose it wasn't quite the proper caper, from an ethical standpoint, for the man to take advantage of the Company any such way as this, but a mechanical paper cannot properly deal with ethics. It might be said that the man wasn't honest, because he didn't do his best and took more pay from the company than his services were worth, but if you say this, how then about my friend, the boss? Was it honest for him to take *his* pay from the Company, as boss of the shop, when by his own confession he didn't know enough about running the shop to know whether a certain piece of work was worth $3.00 or $1.35 to make?

What business has he to be boss of the shop anyhow? He is wronging the company (if anyone is) in two ways, whereas the man who did the piece work, wronged the company only in one way, provided he wronged the Company at all. My friend the boss wronged the Company by accepting a salary for a position which by his own confession he is not competent to fill, and secondly, by pretending to know his business, he lets his men get the best of him on piece work prices, for which the Company has to settle. Men in the shop are not fools; I have worked in the shop too many years myself to wish to believe they are. They may not be always superlatively brilliant, but when the boss doesn't know his business, it never takes the men in the shop any very great length of time "to get onto it," and the dullest man in the shop, who has been brought up in the shop, knows about how long it will take him to do a piece of work.

The piece work question is a vexed one, and always will be as long as a man knows that he will be cut as soon as he begins to make a good thing. I am a little afraid that under the circumstances *I* would nurse *my* job a little, and let the "soft thing" hold as long as the ignorance of the boss would permit it. The man who started in on the piece work at $3.00 had a "soft thing" which constantly grew harder until he is now down to "hard pan" at $1.35, but the chances are that if he didn't know for an absolute fact that he would be cut again, he would still find some way to make a little more than he is now making at $1.35.

It comes to this: The interests of the employer and workman are exactly opposite when work is done by the piece. Some scheme whereby the interests can be made identical would appear to be the only way out of the difficulty. I do not know if it is possible to get up a perfect scheme of this sort, but the nearest approach to it that I have ever seen or heard of is the "premium plan," the credit for putting which in proper practical working shape must be given to Mr. F. A. Halsey; but even this presupposes a knowledge on the part of the boss of whether one hour or one week is a fair length of time in which to whittle a plug to fit a hole in a cider barrel.

By this plan the saving on increased efficiency of the workman is equitably divided between the company and the man, and the more the man makes the more the Company makes, and the more the Company the more the man makes also: that is, the rule works both ways.

I hope my friend the boss will forgive me, and that my friend the editor of MACHINERY will get Mr. Halsey to give him a full and clear practical description of the premium plan, for publication.

BEEN THERE.

## ECKLEY B. COXE.

The many friends of Eckley B. Coxe were pained to learn of his rather sudden death on May 13th. Born in 1839, he graduated from the University of Pennsylvania in 1858, completing a scientific course of three years in Europe. In 1865, together with his brother, he commenced mining operations in the Upper Lehigh region, and produced one of the most complete mining plants in existence. He was highly connected with many engineering societies and last year was president of the American Society of Mechanical Engineers. Engineering circles have lost a devoted worker and his workmen a kind and considerate employer.

## FOR THE YOUNG ENGINEER—(2).

WM. O. WEBBER.

In ascertaining the horse power of your engine the diagram is to be measured by your planimeter, and a good cheap one can be bought so low now, that it is not worth while to measure the diagrams in the old way by laying down an abscissa and ordinates and getting the average of them. But having measured your diagram three or four times and taking the average of your readings, multiply this by the scale of your spring and divide by the length of your diagram, between perpendiculars, in inches and hundredths, and this will give you the mean effective pressure, this multiplied by the area of the piston, less half the area of the piston rod, multiplied by the number of revolutions per minute, multiplied by the feet travel of the piston in one com-

plete revolution, this product being divided by 33,000 will give you the indicated horse power of your engine. As the average engine consumes about 10 per cent. of its power in its own friction, the available power will be about 10 per cent. less than what you obtain from the indicator.

Example: $18\times24$ engine, 80 pounds steam, 150 revolutions per minute. Area of card = 2.8 inches, length 3.5, 50 spring in indicator, because

$$\frac{2)80}{40+10=50.}$$

$2.8\times50=140\div3.5=40$ pounds as the mean effective pressure.

Area of 18 inch cylinder = 254.46 less ½ area of 3 inch piston rod

$$=\frac{3.534}{251.926}$$

$$\frac{40\times251.926\times150\times4 \text{ feet stroke}}{33000}$$

$=183.27$ H. P. by indicator, or indicated horse power; this less 10 per cent. $=164.94$ or 165. available horse power.

In a compound engine $28\times60$ inches high, and $48\times60$ inches low pressure cylinders, 115 lbs. steam, 65 revolutions, piston rod 4⅜ inches diameter, high pressure cylinder diagram $=2.93$ square inches, 60 spring, length of card 4.9375 inches.

$$\frac{2.93\times60}{4.9375}=35.6$$

mean effective pressure.

$$\frac{35.6\times607.8\times65\times10}{33000}$$

$=426.19$ H. P.

Low pressure $48\times60$.

We find that the terminal pressure by the card in high pressure cylinder is 12 pounds; this plus 15 pounds for a perfect vacuum would be 27; so we use a 20 spring.

Area of diagram from low pressure cylinder = 3.36 sq. inches, card 5.2 in. long.

$$\frac{3.36\times20}{5.2}=12.9 \text{ M. E. P. in low pressure cylinder.}$$

$$\frac{12.9\times1801.55\times65\times10}{33000}=457.75$$

Indicated H. P. high pressure cylinder $=426.19$

Total indicated H. P., $=883.94$

and a triple expansion engine would be carried out in the same manner.

It is often quite handy to have a ready rule for figuring the approximate horse power of engines, of which you know the cylinder diameter and stroke. The usual rating is to assume 80 pounds boiler pressure and engine cutting off at ¼ stroke, giving approximately 40 lbs M. E. P., a piston speed of 600 feet per minute; with these as constants three-quarters of the area of your cylinder = maximum horse power. In an $18\times24$ engine = 254. area $\times$ ¾ $=190.5$.

TABLE TO FIND STEAM ACCOUNTED FOR BY INDICATOR CARDS.

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 117.300 | 121.015 | 124.717 | 128.406 | 132.083 | 135.748 | 139.399 | 143.075 | 146.665 | 150.279 |
| 4 | 153.880 | 157.514 | 161.137 | 164.750 | 168.353 | 171.945 | 175.527 | 179.098 | 182.659 | 186.210 |
| 5 | 189.750 | 193.336 | 196.914 | 200.483 | 204.044 | 207.598 | 211.142 | 214.679 | 218.208 | 221.728 |
| 6 | 225.240 | 228.799 | 232.351 | 235.897 | 239.437 | 242.970 | 246.497 | 250.017 | 253.531 | 247.039 |
| 7 | 260.540 | 264.056 | 267.566 | 271.071 | 274.570 | 278.063 | 281.550 | 285.031 | 288.506 | 291.976 |
| 8 | 295.440 | 298.922 | 302.400 | 305.872 | 309.338 | 312.800 | 316.256 | 319.708 | 323.154 | 326.594 |
| 9 | 330.030 | 333.488 | 336.941 | 340.389 | 343.833 | 347.273 | 350.707 | 354.137 | 357.563 | 360.984 |
| 10 | 364.400 | 367.842 | 371.280 | 374.714 | 378.144 | 381.570 | 384.992 | 388.410 | 391.824 | 395.234 |
| 11 | 398.640 | 402.064 | 405.485 | 408.902 | 412.315 | 415.725 | 417.131 | 422.534 | 425.933 | 429.328 |
| 12 | 432.720 | 436.120 | 439.517 | 442.911 | 446.301 | 449.688 | 453.071 | 456.451 | 459.828 | 463.200 |
| 13 | 466.570 | 469.950 | 473.326 | 476.699 | 480.068 | 483.435 | 486.798 | 490.159 | 493.516 | 496.869 |
| 14 | 500.220 | 503.596 | 506.968 | 510.338 | 513.706 | 517.070 | 520.432 | 523.790 | 527.146 | 530.500 |
| 15 | 533.850 | 537.213 | 540.573 | 543.930 | 547.285 | 550.638 | 553.987 | 557.334 | 560.679 | 564.011 |
| 16 | 567.360 | 570.713 | 574.063 | 577.411 | 580.757 | 584.100 | 587.441 | 590.780 | 594.115 | 597.449 |
| 17 | 600.780 | 604.109 | 607.435 | 610.759 | 614.081 | 617.400 | 620.717 | 624.031 | 627.343 | 630.653 |
| 18 | 633.960 | 637.265 | 640.567 | 643.867 | 647.165 | 650.460 | 653.753 | 657.043 | 660.331 | 663.617 |
| 19 | 666.900 | 670.200 | 673.498 | 676.793 | 680.086 | 683.378 | 686.666 | 689.953 | 693.238 | 696.520 |
| 20 | 699.800 | 703.098 | 706.394 | 709.688 | 712.980 | 716.270 | 719.558 | 722.844 | 726.128 | 729.410 |
| 21 | 732.690 | 735.968 | 739.244 | 742.518 | 745.790 | 749.060 | 752.328 | 755.594 | 758.858 | 762.120 |
| 22 | 765.380 | 768.660 | 771.938 | 775.215 | 778.490 | 781.763 | 785.034 | 788.303 | 791.570 | 794.836 |
| 23 | 798.100 | 801.362 | 804.622 | 807.881 | 811.138 | 814.393 | 817.646 | 820.897 | 824.146 | 827.334 |
| 24 | 830.640 | 833.908 | 837.175 | 840.440 | 843.703 | 846.965 | 850.225 | 853.484 | 856.741 | 859.996 |
| 25 | 863.250 | 866.502 | 869.753 | 873.002 | 876.249 | 879.495 | 882.739 | 885.982 | 889.223 | 892.462 |
| 26 | 895.700 | 898.936 | 902.171 | 905.404 | 908.635 | 911.865 | 915.093 | 918.320 | 921.545 | 924.768 |
| 27 | 927.990 | 931.210 | 934.429 | 937.646 | 940.813 | 944.075 | 947.287 | 950.498 | 953.707 | 956.914 |
| 28 | 960.120 | 963.352 | 966.583 | 969.813 | 973.041 | 976.268 | 979.493 | 982.717 | 985.939 | 989.160 |
| 29 | 992.380 | 995.598 | 988.815 | 1002.031 | 1005.245 | 1008.458 | 1011.669 | 1014.879 | 1018.087 | 1021.294 |
| 30 | 1024.500 | 1027.704 | 1030.907 | 1034.109 | 1037.309 | 1040.508 | 1043.705 | 1046.901 | 1050.095 | 1053.288 |
| 31 | 1056.480 | 1059.670 | 1062.859 | 1066.047 | 1069.233 | 1072.418 | 1075.601 | 1078.783 | 1081.963 | 1085.142 |
| 32 | 1088.320 | 1091.528 | 1094.736 | 1097.942 | 1101.146 | 1104.350 | 1107.552 | 1110.754 | 1113.954 | 1117.152 |
| 33 | 1120.350 | 1123.546 | 1126.742 | 1129.936 | 1133.128 | 1136.420 | 1139.510 | 1142.700 | 1145.838 | 1149.074 |
| 34 | 1152.260 | 1155.444 | 1158.628 | 1161.810 | 1164.990 | 1168.170 | 1171.348 | 1174.526 | 1177.702 | 1180.876 |
| 35 | 1184.050 | 1187.222 | 1190.394 | 1193.564 | 1196.732 | 1199.900 | 1203.066 | 1206.232 | 1209.396 | 1212.558 |
| 36 | 1215.720 | 1218.917 | 1222.112 | 1225.307 | 1228.500 | 1231.693 | 1234.884 | 1238.075 | 1241.264 | 1244.453 |
| 37 | 1247.640 | 1250.827 | 1254.012 | 1257.197 | 1260.380 | 1263.563 | 1266.744 | 1269.925 | 1273.104 | 1276.283 |
| 38 | 1279.460 | 1282.637 | 1285.812 | 1288.987 | 1292.160 | 1295.333 | 1298.504 | 1301.675 | 1304.844 | 1308.013 |
| 39 | 1311.180 | 1314.347 | 1317.512 | 1320.677 | 1323.840 | 1327.003 | 1330.164 | 1333.325 | 1336.484 | 1339.643 |
| 40 | 1342.800 | 1345.957 | 1349.112 | 1352.267 | 1355.420 | 1358.573 | 1361.724 | 1364.875 | 1368.024 | 1371.173 |
| 41 | 1374.320 | 1377.467 | 1380.612 | 1383.757 | 1386.900 | 1390.043 | 1393.184 | 1396.325 | 1399.464 | 1402.603 |
| 42 | 1405.740 | 1408.877 | 1412.012 | 1415.147 | 1418.280 | 1421.413 | 1424.544 | 1427.675 | 1430.804 | 1433.933 |
| 43 | 1437.060 | 1440.230 | 1443.398 | 1446.566 | 1449.734 | 1452.900 | 1456.066 | 1459.230 | 1462.394 | 1465.558 |
| 44 | 1468.720 | 1471.882 | 1475.042 | 1478.202 | 1481.362 | 1484.520 | 1487.678 | 1490.834 | 1493.990 | 1497.146 |
| 45 | 1500.300 | 1503.454 | 1506.606 | 1509.758 | 1512.910 | 1516.060 | 1519.210 | 1522.359 | 1525.506 | 1528.654 |
| 46 | 1531.800 | 1534.946 | 1538.090 | 1541.234 | 1544.378 | 1547.520 | 1550.662 | 1553.802 | 1556.942 | 1560.082 |
| 47 | 1563.220 | 1566.358 | 1569.494 | 1572.630 | 1575.766 | 1578.900 | 1582.034 | 1585.166 | 1588.298 | 1591.430 |
| 48 | 1594.560 | 1597.690 | 1600.818 | 1603.946 | 1607.074 | 1610.200 | 1613.326 | 1616.450 | 1619.574 | 1622.698 |
| 49 | 1625.820 | 1628.942 | 1632.062 | 1635.182 | 1638.302 | 1641.420 | 1644.538 | 1647.654 | 1650.770 | 1653.886 |
| 50 | 1657.000 | 1660.114 | 1663.226 | 1666.338 | 1669.450 | 1672.560 | 1675.670 | 1678.778 | 1681.886 | 1684.994 |
| 51 | 1688.100 | 1691.206 | 1694.310 | 1697.414 | 1700.518 | 1703.620 | 1706.722 | 1709.822 | 1712.922 | 1716.022 |
| 52 | 1719.120 | 1722.218 | 1725.314 | 1728.410 | 1731.506 | 1734.600 | 1737.604 | 1740.786 | 1743.878 | 1746.970 |
| 53 | 1750.060 | 1753.150 | 1756.238 | 1759.327 | 1762.414 | 1765.500 | 1768.586 | 1771.670 | 1774.754 | 1777.838 |
| 54 | 1780.920 | 1784.002 | 1787.082 | 1790.162 | 1793.242 | 1796.320 | 1799.398 | 1802.474 | 1805.550 | 1808.626 |
| 55 | 1811.700 | 1814.829 | 1817.957 | 1821.084 | 1824.211 | 1827.338 | 1830.463 | 1833.588 | 1836.713 | 1839.837 |
| 56 | 1842.960 | 1846.083 | 1849.205 | 1852.326 | 1855.447 | 1858.568 | 1861.687 | 1864.806 | 1867.925 | 1871.043 |
| 57 | 1874.160 | 1877.277 | 1880.393 | 1883.508 | 1886.623 | 1889.738 | 1892.851 | 1895.964 | 1899.077 | 1902.189 |
| 58 | 1905.300 | 1908.411 | 1911.521 | 1914.630 | 1917.739 | 1920.848 | 1923.955 | 1927.062 | 1930.169 | 1933.275 |
| 59 | 1936.380 | 1939.485 | 1942.589 | 1945.692 | 1948.795 | 1951.898 | 1954.999 | 1958.100 | 1961.201 | 1964.301 |
| 60 | 1967.400 | 1970.499 | 1973.507 | 1976.694 | 1979.791 | 1982.888 | 1985.983 | 1989.078 | 1992.173 | 1995.267 |

COMPUTED BY E. W. THOMPSON, 1881.

Find number corresponding to absolute (theoretical) terminal pressure and divide by M. E. P. Example: Terminal 20 lbs. above atmosphere $+14.7=34.7$ lbs. absolute, number $=1174.526\div40$ lbs. M. E. P. $=29.39$ lbs. steam or water per H. P. hour.

Another rule on the same basis of assumption, and one giving slightly more conservative figures, is to square the diameter of the cylinder and take one-half of the amount for the horse power.

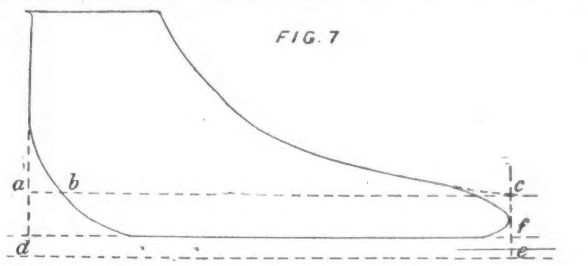



FIG. 7

In an $18\times24$ engine $=18^2=324\times\frac{1}{2}=162$ H. P. For a compound engine a good rough rule is to square the diameter of low pressure cylinder, multiply this by the square root of the steam pressure, this by one-half the piston speed in feet per minute, and divide by 8500; this for our 28 and $48\times60$ inch engine, 65 revolutions, 115 pounds steam, would be

$$\frac{2304\times10.7\times325}{8500}=$$

942 H. P.

This same rule will apply to a triple or quadruple expansion engine, entirely ignoring all but the low pressure cylinder.

To ascertain the amount of steam used by an engine from the indicator cards, the plan in use by the Buckeye Engine Co. is the simplest, and involves the use of a table published by E. W. Thompson in the *American Machinist*, in 1881.

Referring to Fig. 7 draw a vertical line at each end of the diagram exactly defining its length and continue the expansion curve to $c$ as if the exhaust had not opened from $c$ draw the line $a\ c$ parallel with the atmospheric line, measure the terminal pressure at $c$ from the vacuum line $d\ e$, they draw 14.7 pounds below and parallel to the atmospheric line and find in the table the number corresponding to it. Divide the number thus found by the mean effective pressure; the quotient will be the steam accounted for by the indicator per horse power per hour, uncorrected for clearance and compression. To make this correction multiply the result obtained above by the length of the line $b\ c$ and divide by the length of the line $a\ c$.

Example: Suppose the height $c\ f=20$ pounds by your indicator scale, $20+14.7=34.7$; referring to table, $34.7=1174.526$. We will suppose that our mean effective pressure was 40 pounds,

$$\frac{1174.526}{40}=29.36$$

pounds of steam or water per horse power per hour; $29.36\times4$. The length of line $b\ c=117.47$ divided by line $a\ c=4.3=27.3$ pounds of steam or water corrected for clearance and compression.

Entered at the Post Office in New York City as Second-class Mail Matter.

# MACHINERY,

A practical journal for Machinists and Engineers and for all who are interested in Machinery.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

411 AND 413 PEARL STREET, NEW YORK CITY.

FIFTY CENTS A YEAR. - - - - FIVE CENTS A COPY

FOREIGN SUBSCRIPTIONS, SEVENTY-FIVE CENTS A YEAR; POSTAGE PREPAID.

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## JUNE, 1895.

### Special Service Department.

We will furnish without charge to readers of Machinery, the name and address of any desired manufacturer of machinery, tools, or appliances.

The question of fire-room management is very forcibly brought to notice in Prof. Carpenter's article in this issue; and the writer is glad to note his position regarding the duties of the firemen, which, while rough and hard work, require a large amount of skill for their proper performance. This should not go unrewarded, and probably the "premium plan," which has been mentioned here before, offers one of the best solutions and does justice to all concerned. The saving which it is shown can be effected by a careful man is too important to be overlooked or to go unrecognized, and a position which can cut such a figure in the economical performance of a large plant, should not be underpaid nor occupied by an incompetent man, as a few dollars saved in wages may be wasted many times over in fuel uselessly thrown into the furnace.

* * *

### MAKING NOTES.

Too many mechanics, and probably other men as well, are continually neglecting to make notes of occurrences which interest them and which might prove of value at some later day; relying on memory, the most uncertain of all our faculties, for the desired information. To the shopman with his greasy hands there is some excuse for not making notes on the spot—circumstances will not permit it; but to the mechanical or constructing engineer no such excuse is open, and yet how many neglect to record information that might prove of great value in after years. A case comes to mind where such data, jotted down in the note-book of the engineer in charge, would have been of service later, but it could not be obtained; nobody remembered exactly, and exactness was necessary to render the information of real value.

The habit of carefully taking notes should be cultivated more than it is, for there is a period in the life of nearly every young mechanic when he takes notes indiscriminately; this soon passes and all note-taking ceases, to the loss of everybody concerned.

The record of steam and coal consumption to date, with the principal facts attending the test, capacity of engines, steam carried, ratio of cylinders if a compound engine, and anything else of importance, not forgetting the date, should be kept by every one interested in steam engineering for reference in case it is needed. Where these are too extended for notes (and this applies to clippings also), an index showing where the desired information can be found will be found valuable. This can readily be kept as a "card catalog," or can be indexed into blank books as the person prefers; but any reading mechanic or engineer will find it to his advantage to keep some kind of a record whereby he can trace such information as he is likely to need in the future, for much of the value of this information consists in the ability to lay hands on it when wanted.

* * *

### THE VALUE OF TESTS.

Unfortunately all tests are not reliable; but in addition to the unintentional errors which occur from an incomplete conception of the requirements of the case, or from the difference in conditions too often overlooked, we find numerous instances where tests have been made with a very evident intent to deceive, either by actual misrepresentation or what is fully as bad—the omission of some important data which would greatly modify the result.

One instance recently came to the writer's notice which will serve to illustrate the latter method. Two engineering appliances, which we will style A and B, were in use in a plant where the duty was particularly severe. One gave much better results than the other, but neither all that was claimed, owing to the rigorous conditions imposed. The makers of the one (A) giving the poorer results employed an expert who was a recognized authority, to make a comparative test for the purpose of showing the superiority of that appliance. The test in this case was decidedly against A, so the expert visited another plant where the conditions were less severe, and made a test which naturally showed more favorable results for A than the results showed by B *in the first test*, leaving the public to infer that both tests were made under similar conditions; and there is little doubt that many sales have been made and medals awarded on the strength of such results.

A test which does not give all available data bearing on the subject, and which is not conducted fairly and accurately under similar conditions, if for purposes of comparison, is of little value to any one.

## CORRECT COSTS, OR THE PARALLEL COLUMN IN THE COUNTING ROOM.

HENRY HESS.

The usual method of determining the cost of product consists in adding actual cost of raw material, actual cost of labor and shop expense. Shop expense is usually determined annually by subtracting from the total expenses of the business the sum of the expenditures for raw material and labor, and dividing the balance by the annual labor cost; the resulting ratio then gives the average relation of labor and shop expense for that year, and is used as a basis for the next year's costs.

COST OF A SMALL MACHINE BY USUAL METHOD AS ABOVE.

| BIG SHOP. | | LITTLE SHOP. | |
|---|---|---|---|
| Raw material | $100.00 | Raw material | $100.00 |
| Labor | 160.00 | Labor | 178.00 |
| Shop expense at 125% of labor | 200.00 | Shop expense at 50% of labor | 89.00 |
| Total | $460.00 | Total | $367.00 |

Total cost in big and little shop differs by $93.00, or is about 25 per cent. more in the big shop than in the little one; yet for both raw material is the same, while as regards labor the better equipment of the big shop gives it somewhat the advantage. But the little shop can sell at a profit at a price that means apparent loss to its big competitor.

DETERMINATION OF SHOP EXPENSE, USUAL METHOD.

| BIG SHOP. | | LITTLE SHOP. | |
|---|---|---|---|
| Year's cost of raw material | $200,000.00 | Year's cost of raw material | $10,000.00 |
| Year's cost of labor | 2,000,000.00 | Year's cost of labor | 100,000.00 |
| Total | $2,200,000.00 | Total | $110,000.00 |
| Grand total year's expenses | 4,700,000.00 | Grand total year's expenses | 160,000.00 |

Big shop: Shop exp. $= \frac{4,700,000 - 2,200,000}{2,000,000} = 1.25$ or 125 per cent. of labor cost.

Little shop: Shop expense $= \frac{160,000 - 110,000}{100,000} = .5$ or 50 per cent of labor cost.

DETERMINATION OF COST, CORRECT METHOD.

SMALL MACHINE.

| BIG SHOP. | | LITTLE SHOP. | |
|---|---|---|---|
| Raw material | $100.00 | Raw material | $100.00 |
| Labor | 160.00 | Labor | 178.00 |
| Interest and depreciation of tools actually used on small machine, for time of such use. | 68.00 | Interest and depreciation of tools actually used on small machine, for time of such use. | 50.00 |
| General expenses | 39.00 | General expenses | 35.00 |
| Total | $367.00 | Total | $363.00 |

Total cost for a big and little shop is substantially the same.

LARGE MACHINE.

| BIG SHOP. | | LITTLE SHOP. |
|---|---|---|
| Raw material | $3,000.00 | Cannot build it. |
| Labor | 8,000.00 | |
| Interest and depreciation of tools actually used on large machine, for time of such use | 9,000.00 | |
| General expenses | 1,400.00 | |
| Total | $21,400.00 | |

FINDING GENERAL EXPENSES, CORRECT METHOD.

From the total year's expenses subtract the sum of the year's costs for raw material, for labor, for interest and depreciation of tools and plant, in so far as they have been charged to individual product. Divide the balance by the total cost of labor plus the above total charge for interest and depreciation of tools and plant, and the result will be the desired ratio. In other words, each tool is to be regarded as a workman having a fixed rate of pay, made up from the cost of power delivered to such tool, the interest on first cost, the depreciation, the interest on cost of plant required to house such tool, and the depreciation of this housing. The interest and depreciation of tool and plant during the time when they are not in use will show up in the general expense ratio, which will therefore be somewhat higher for the large than for the small shop.

For the big shop and small machine the elements of general expense plus actual tool cost will figure out as 66.7 per cent. of the labor cost, while for the large machine they increase to 130 per cent. Evidently increasing size of machine increases this ratio; and this is correct, since to build large machines requires a costly outfit of large tools and much real estate to house them and the product. It will not do to strike an annual average ratio, as is usual, because this results in an apparent increase of cost of the small work and an apparent decrease of the large; and it is not true that the ultimate financial result to the shop is the same, on the assumption that the overprofit on the small work pays for the underprofit on the large, for the simple reason that the small work goes to the competitor with the small shop, and *apparently* lower shop expense.

The correct cost of a given product is the cost of the raw material plus the cost of labor, *plus the interest and depreciation of that part of the total plant directly concerned in its production during the actual time of such use*, plus a general charge due to those factors of cost which are not directly chargeable to any particular product. In some establishments this general charge will most correctly take the form of a percentage on the labor, plus plant cost, while in others the cost of raw material rather than labor will be used as a basis for this ratio.

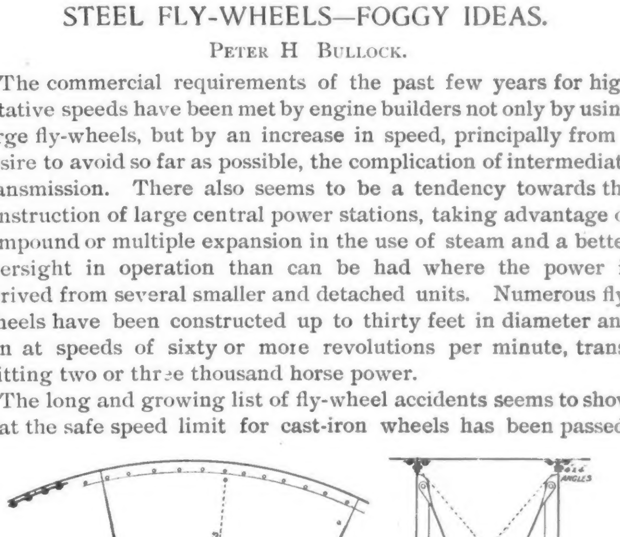
* * *

## STEEL FLY-WHEELS—FOGGY IDEAS.

PETER H BULLOCK.

The commercial requirements of the past few years for high rotative speeds have been met by engine builders not only by using large fly-wheels, but by an increase in speed, principally from a desire to avoid so far as possible, the complication of intermediate transmission. There also seems to be a tendency towards the construction of large central power stations, taking advantage of compound or multiple expansion in the use of steam and a better oversight in operation than can be had where the power is derived from several smaller and detached units. Numerous fly-wheels have been constructed up to thirty feet in diameter and run at speeds of sixty or more revolutions per minute, transmitting two or three thousand horse power.

The long and growing list of fly-wheel accidents seems to show that the safe speed limit for cast-iron wheels has been passed,



and that the formulas used for computing their strength are not safe ones to follow. The conditions under which these wheels failed have been different. Some have been wrecked from external causes and without any increase in speed; others from internal defects, giving way at a moderate increase in speed, while others have attained unknown speed before letting go. On the other hand it is but fair to state that cases have been known where wheels have attained great speed and yet were not wrecked. Some large wheels have recently been strengthened by larger rim bolt; in some cases the speed has been slightly reduced and safety attachments put into place, and in some cases wheels have been replaced by others of better and stronger design.

With the necessity for high speed recognized, the first thing to be considered should be absolute safety, and the next, cost. It is

to be feared, however, that these factors are often reversed and the matter of cost allowed to outweigh the question of safety. Those who have had the experience of a wrecked wheel do not spare expense in replacing it. A noticeable incident in this direction was the building of a wooden wheel by Supt. Manning, of the Amoskeag Co., at Manchester, N. H., to replace the one wrecked there in October, 1892, and recently another similar one for the Nashua Mfg. Co., to replace theirs wrecked on August 10. There have been other large and serviceable wheels constructed of wood, and in the smaller sizes for the distribution of power there has been a great improvement in quality and accuracy, and the ease with which they can be put into position make them better for many purposes than heavy iron ones.

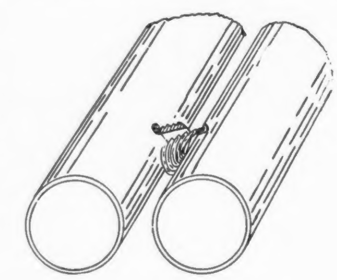
If the question is to be one of safety first, if seems to me that plate steel is the material to use. It could be made of any desired weight and strength, could not be affected by moisture and would be non-combustible. There can be no doubt but that a safe wheel can be made on the composite plan of cast iron and wood, or, if found necessary, entirely of wood, but why not steel? Steel can now be produced at a low price and with great accuracy of shape and form, and from it a wheel might be constructed that would be absolutely safe so far as danger from any probable speed that an engine could acquire. Such a wheel would consist of two heavy flanges on the crank-shaft, with segments of plate steel forming two complete discs extending to the rim, spaced and braced apart with suitable T shapes, and a rolled steel rim secured to the discs with blind riveting. When finished there would be plain surfaces presented to view and also for the air to act upon, a matter of more importance than many are aware of. A fly-wheel is supposed to have strength enough in its rim, and with a good per cent. to spare, to resist the strain due to the centrifugal action of its mass. That is to say that if the rim could be revolved independent of its spokes, that it should retain its shape and integrity from the strength of the metal of which it is composed. While it is probable that in most cases the spokes do add to the strength of the wheel, besides performing their office of holding the rim at a fixed distance from the shaft, it is also very certain that in many cases there are excessive strains in parts of wheels due to improper design or imperfect fitting, and that these strains become intensified almost to the point of fracture by the centrifugal force, and by tension from work done by the belts. Every one must know that cast iron is not the best material to resist such strains, and that in tensile strength it is far inferior to steel or even wrought iron. A steel rim could be made, however, so as to have fully 80 per cent. of the strength of the metal at the riveted joints, and this would give a resisting strength far beyond any probable strain that could be put upon it by the centrifugal action of its mass Such a wheel, however, would not by any means depend solely upon the rim for strength. The discs being continuous from hub to rim would be fit to safely hold the outward throw even if the rim were cut into several pieces and the discs alone depended upon to retain the separate pieces of it in place. It is doubtful if a wheel constructed in any other manner would have the strength of one made as suggested, or that would be safe to run without the hoop strength of the rim. As said before, the principal centrifugal resisting strength of a whee is its rim, and for a given cross-section more strength could be got into a rim made of steel than any other metal.

It is surprising what erroneous ideas some men have about mechanical matters, especially men who hold positions that call for, and which the fact of holding should be a guaranty, of better information. As an illustration I will refer to the Amoskeag fly-wheel accident, where it may be remembered that two belts from the outer sides of the rim run one way and another in the center in an opposite direction, all being held by binders so as to fully encircle three-quarters of rim. A man holding a good mechanical position and referring to the accident and to the fact of the three belts running as above stated, held that the wheel must have been wrecked from some external force or reason, because the belts "being on all parts of the rim and so tight, too," that they alone would keep the wheel from breaking I told this to a waggish engineering friend, who said that the belts probably did hold *some*, also that the same thing could be said of the red paint that ornamented the wheel. Another man who has charge of several boilers said he did not like to blow off boilers under pressure, but did under high temperature, and explained that at 60 pounds gauge the temperature was 307 deg., and that he drew off the steam, *leaving the water just as it was at 307 deg.*, and then drew that off without the *terrific noise*. It only works this way under peculiar circum stances and in very remote sections of the country.

* * *

## A SMALL MISTAKE.

Our illustration shows part of two 3 inch tubes, which were removed from a boiler because each had a hole in it which allowed the water to escape. Between the tubes may be seen a small piece of iron which ruined them. It is a very short piece of pipe about 1¼ inches in diameter, and apparently was chipped off some time when repairs were in progress, and it was not thought necessary to remove it, which was a small mistake, but a rather costly one. It fell down and lodged between these two tubes, and the motion caused by the circulation of the water as it swept over it, wore holes in the tubes as shown. The result was that the plant was shut down while boiler-makers put in two new tubes.



This is but another illustration of the great need of being sure that everything is removed from the inside of a boiler after it has been repaired. When this piece was cut off, it probably flew to some remote part of the boiler, for the engineer in charge assured us that when the boiler was cleaned last there was nothing between the tubes, and we believe this to be a fact, but that it was there somewhere cannot be denied. It is quite possible that it lodged somewhere in the dome, or rather on the shell under the dome, and as it was customary to fill the boiler full of water about once a week, it may have been dislodged in this way and then fell where it was found. This circumstance is not cited as an argument against filling a boiler full of water when necessary, but to show that all chips, filings, etc., should be taken out before the boiler is filled with water.

W. H. W.

* * *

## AN APPLICATION OF THE MILLING MACHINE.

The milling machine has become such a factor in modern shop practice that a brief description of the Double Column Milling Machine, patented by Mr. John L. Bogert, and its application to regular machine work will be interesting. Although a machine which faintly resembled this had been constructed previously, this distinct type came into existence twelve years ago at Flushing, L. I. It has, however, been greatly improved in many important respects, whereby the desirable feature of great rigidity combined with accuracy of vertical adjustment is secured. In the earlier machine this combination could only be secured at

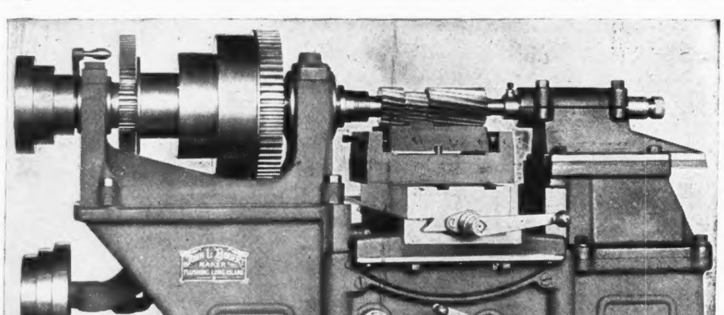


FIGURE 2.

an expense for planing and fitting that was almost prohibitive. The saddle is made in two parts so as to clamp the bearing surfaces instead of depending on gibs held to place by small pointed set screws. The gearing is in the ratio of 10⅓ to 1, front bearing 3 by 5 inches, with a three-step cone for 3-inch double belt. The dead spindle can be adjusted from within 4 inches to 16½ inches from live spindle. The table is $9\frac{9}{16}$ inches wide, 46 to 52 inches long, with an extreme feed of 24 to 30 inches. The carriage is 22 inches long, 10 inches wide, and has arms 18 inches long. An automatic stop adjustable to any desired movement controls the power feed. The saddle has a vertical adjustment of 12¾ inches, bringing the top of table 12¾ inches below the centers in its lowest position.

Fig. 1 shows the machine with the ordinary vise on the table,

the foot-block projecting over saddle, the construction allowing the dead spindle to approach the live spindle very closely, as

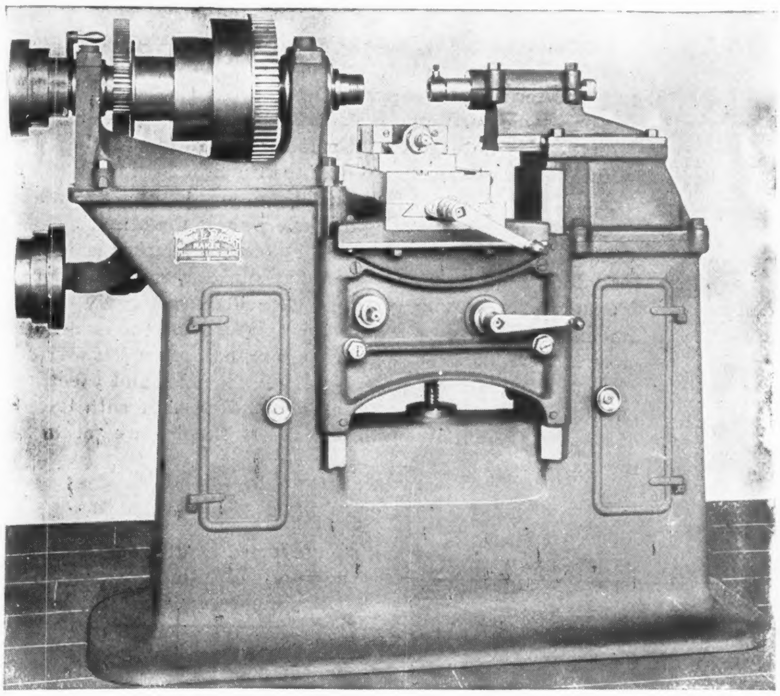


FIGURE 1.

shown, and as the bottom of foot-block is but 5¼ inches below center line, the table can be fed by the horizontal adjusting screw under the projecting foot-block.

Fig. 2 shows the lower part of an ordinary lathe foot-block held in a suitable fixture on the table and having its top surface milled to fit a corresponding surface on the bottom of the upper part of the foot-block. Such a piece of work is well qualified to show the advantage of this tool over a single column miller. These joint surfaces on the lathe foot-blocks are from 6 inches to 18 inches wide, and on account of the tongue and groove can be milled more cheaply than planed.

Fig. 3 shows the foot-block and upper part of column removed, to permit milling the ends of long work. In this particular case an ordinary lathe leg is held in a fixture which is bolted fast to the table. To take all the overhanging strain off the leg and fixture, a cast-iron parallel is placed on the foot-block column with its upper surface lubricated. By means of the vertical adjusting screw, the saddle is lowered until the outer end of the fixture justs rests on the top of the parallel. The drag or pull of the

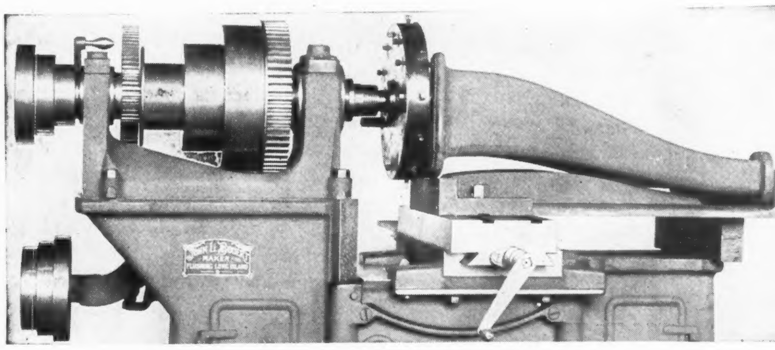


FIGURE 3.

feed-screw, being close to the surface milled, makes possible very nice work on very long pieces. The joint or plane of separation between the two parts of the foot-block column is so located that in the lowest possible position of the saddle the top of the table is above the joint.

Fig. 4 shows a lathe head-stock held in a fixture on the table, and having its jaws milled out to fit the spindle boxes. Work of this description can be much more cheaply milled than planed. This fixture could be easily improved upon, but having done this work for the last thirteen years at a considerable saving over the planer, it still exists, as an example of how not to do it. Too much stress can hardly be laid on the necessity of using large arbors—the larger the better—and stiff fixtures, if good milling is to be done; always bearing in mind that the lifting strain on a wide mill is many times the upward thrust of a planer tool.

* * *

## A MECHANIC'S NOTE BOOK.

THE use of limit gages is probably the best as well as the cheapest way to introduce accuracy into a shop not accustomed to fine measurements.

TIGHT belts mean hot bearings in too many cases. Here is where rope drives, properly arranged, are advantageous; for almost any driving power can be had without tending to heat the bearings, simply by giving another wrap around driver or driven as the case may be. This is an advantage in many ways and deserves to be better understood.

WHEN your belts begin to slip, screech and break, find out the cause, they may be oily and need attention, or, and this is the usual trouble, they may be overloaded. If this is the case, don't try to tighten them until they are ready to snap, but put on a wider belt if possible; or if you cannot do this, use a heavier belt that will stand more abuse, but this isn't good policy.

IF you want to know the value of a heating or ventilating device, aside from cost of its operation, ask the men in the shop, not those who are in the office most of the time. The writer has seen the thermometer in the shop register 28 deg. at seven o'clock, while the men in the office had nothing but praise for the system —the writer had other opinions regarding it.

Too many men commend any tool that is new, and consider it a

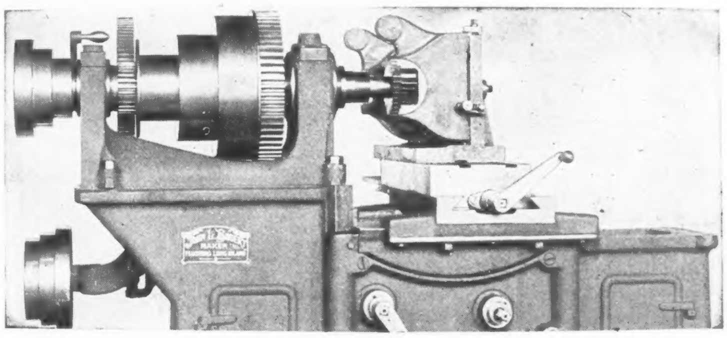


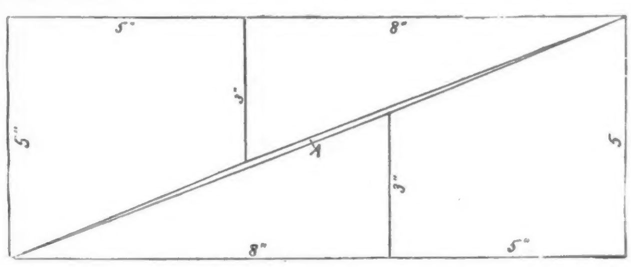
FIGURE 4.

"marked advance" over present practice, while on the other hand many hold the opposite view, and condemn new tools because they "always got along with the old ones." Both courses are unwise, and as far as possible a tool should be judged by its merits regardless of age; but when we know a tool has done good work it should be counted in its favor.

* * *

## MAKING 64 EQUAL 65.

A correspondent sends the old problem of taking an 8 inch square and dividing it into four parts which, when reassembled as in the figure, will make a rectangle 13 by 5 inches with 65 square inches in place of the 64 it previously contained. This is very much like taking a gallon of water containing 231 cubic inches in a square can and by pouring it into one of rectangular or other shape increase



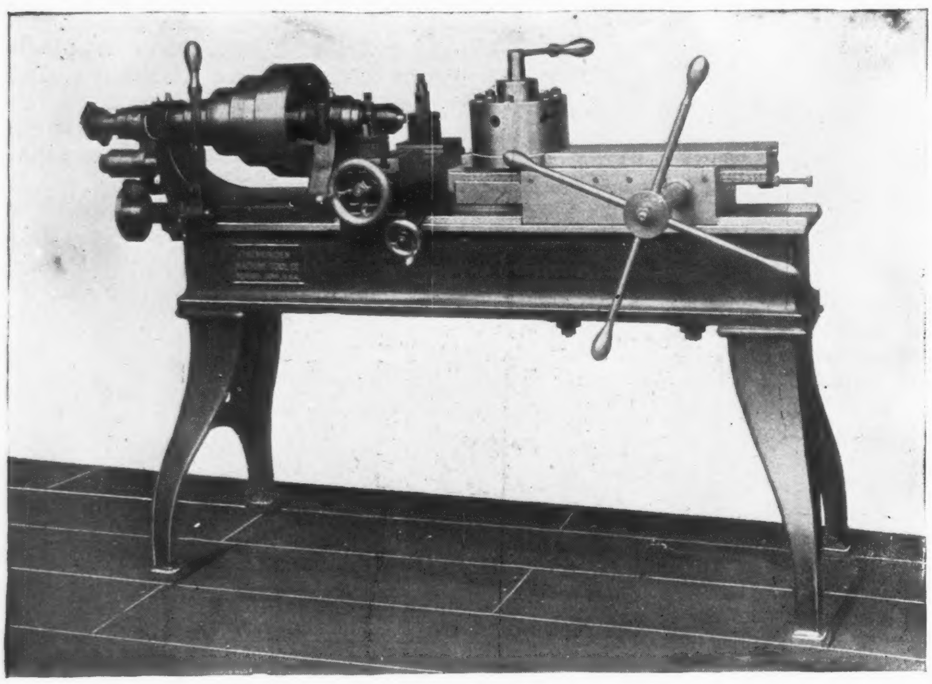

its volume to, say 235 cubic inches. Dividing one apple into two parts doesn't make it weigh any more or increase its use-

fulness, unless in a boarding-house pie and the same reasoning applies to mechanics. Referring to the figure it will be seen that the extra inch comes from the space A between the angles, which is not considered in a rough measurement. Two and two always make four, regardless of how they are manipulated.

* * *

## IMPROVED 18-INCH TURRET LATHE.

The popularity of some of the special features of the combined forming and turret lathe of the Meriden Machine Tool Co., has created a demand for a plain turret lathe embodying these features which has resulted in the bringing out of the machine shown in the cut. The special features are the longitudinal adjustment of the cut-off slide (by means of the wheel at the lower right hand of the slide) and the easy and convenient method of tightening and loosening the chuck, by means of the lever at the front of the head, which has a forward motion, instead of the conventional lever at the back of the head, with an inconvenient and side-straining motion. It will be seen that the longitudinal movement of the cut-off slide gives to it all the motions of an engine lathe carriage, in consequence of which many jobs, such as knurling a long piece after the turret work is done, or squaring a true shoulder for a tight joint, etc., etc., can



be done on this machine, which, without this motion, would need to be taken to an engine lathe for another operation.

The turret and slide are of good design: the lock-bolt shoots into the index ring almost directly under the tools, instead of at the back of the turret, as is usual in many turret lathes. The lock-bolt itself is 12 inches long, and is backed by a spring 12 inches long. The distance from center of turret holes to top of slide is 3 inches, giving ample room to swing large or complicated turret tools. The front spindle bearing is 2¼ inches diameter by 5¼ inches long, and the cone takes a 4-inch belt.

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### A. M. WELLINGTON.

By the death of Mr A. M. Wellington, editor and one of the proprietors of *Engineering News*, railway engineering circles lose a well-known worker. Being in poor health for over a year, an operation was performed as a last resort, which resulted in death from heart failure on May 16th. His work in various railway projects, as editor of the *Railroad Gazette*, and since 1887 in connection with the *Engineering News* is too well-known to require comment, and his loss will be keenly felt.

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Mr. S. Ashton Hand, well known in engineering circles, has entered a new field, specialties in photography, in which line he has made quite a reputation. The firm name is Pancoast & Hand, Heed Building, 1213 Filbert street, Philadelphia, Pa.

## BOILER HEATING SURFACE.

Conrad Skarstedt.

There is a great diversity among engineers generally and boiler-makers especially, as to which is the proper surface to be considered as heating surface, the one on the fire side or the one on the water side, some preferring the fire side, some the water side and some partly the fire side and partly the water side.

As there is no established rule for the rating of the heating surface it would be well to look into the subject a little, as a boiler with a large number of tubes will have considerable difference in heating surface by being figured one way or the other.

Suppose we have an iron plate 15 feet $10\frac{1}{16}$ inches wide and ½ inch thick and expose one of its flat surfaces to the heat from a fire and the other one to water, we will have exactly the same amount of heating surface whether we use the one or the other, or 15.84 square feet per every foot length of plate. If we roll the plate to a cylinder we get 5 feet inside diameter and 5 feet 1 inch outside diameter. In using this for a boiler shell, with, say, half of its circumferential length exposed to the fire, we get for heating surface

$$\frac{\text{circumference of } 60}{2 \times 12} = 7.85$$

square feet of heating surface if using the water side, and

$$\frac{\text{circumference of } 61}{2 \times 12} = 7.98$$

square feet if using the fire side. This, for every foot length of the plate would be, if the plate was only 10 feet long, 78.5 in the one case and nearly 80 square feet in the other. Suppose the boiler had 80 3-inch tubes, the heating surface on the water side would be

$$\frac{9.42 \times 80}{12} = 62.8$$

square feet, and on the fire side it would be

$$\frac{8.74 \times 80}{12} = 58.3$$

square feet all per foot of length, 9.42 and 8.74 being the outside and inside circumference of a 3-inch tube. If the heating part of the tubes were 10 feet long, we would get the values of 628 and 583 square feet of heating surface for the same tubes.

A boiler of this diameter is usually 16 feet long, and the heating surface in shell and tubes would consequently be given in *round numbers* as $(7.85+62.8) \times 16 = 1130.4$ and $7.98+58.3) \times 16 = 1060.5$ square feet for the same boiler with a difference of about 70 square feet. It ought, therefore, always to be stated which surface is used as heating surface. It does not, however, alter the value of the total heating surface whichever surface is used, as the same amount of water will be evaporated, but in the one case each unit of heating surface is more effective than in the other case. This is quite natural. In the given example a certain amount of heat is given off from the fire to 1060.5 square feet of surface. The heat penetrates the iron and the same heat minus what is converted into work, working itself, so to speak, through the plate, is delivered to the water from a larger surface or 1130.4 square feet. Thus it does not matter much which surface is used, if it only is stated in connection with the heating surface; but it is wrong to use both surfaces for the same boiler, as some do, using the fire surface on the shell and water surface on the tubes in a fire-tube boiler, as it is somewhat misleading.

Those who use the water surface argue that this is the proper surface to use, as it is the surface from which the water is heated, and the advocates for the fire surface that this is the proper, because it is the surface that is heated from the fire.

The cause of these remarks was a lecture on boilers, delivered before an engineering society, in which the author first says that the smaller surface is the right one to use in figuring the heating surface, because in a fire tube boiler "the fire has access only to the small inside area" ('surface probably better) "or in a water

tube boiler, while the fire has access to the larger outside area, the smaller inside area only is effective in giving up the heat to the water." This theory I consider to be wrong, according to previous argument. He says further in the same lecture, "If we straightened out this portion of the boiler" (5 feet diameter, 16 feet long) "we should have a rectangular sheet 16 feet long and a width of half the circumference of the the boiler, or

$$\frac{5\times 3.1416}{2} = 7.854$$

feet. Multiply this by the length and we have 125.664 square feet in the shell." Theoretically this is not correct. The diameter of a boiler means the inside diameter of the largest sheet, and the length is measured from outside to outside of the heads, and measures never the given length by about one inch, so that the tubes can be beaded or expanded over the heads. He means, of course, if we straightened out the *inside surface* of the sheet, because if we straighten out the sheet we would not get

$$\frac{5\times 3.1416}{2}$$

but

$$\frac{(5+\text{ thickness of the sheet})\times 3.1416.}{2}$$

Then we should not multiply by 16, but by the length of the boiler, which probably is 15 feet 11 inches minus twice the thickness of the heads. The same with regard to the lengths of the tubes. I know that this is not always done in practice; it is, therefore, unnecessary to use 3.1416, for $\pi$ 3.14 is plenty, as the computed heating surface always will be larger than the real. If the circumference is taken from a table one decimal is sufficient. Then coming to the heads the author states that we get the correct length of the arch comprising the segment by "passing the tape around the bottom of the *boiler*, from end to end of the arch line." This is not correct either; it should be, around the bottom of the *head*.

As a rule boiler-makers use two-thirds of the shell in computing the heating surface. This will, of course, always give too large a heating surface, as the brickwork is never closed in to the boiler so high up. In that case $\pi = 3$ ought to be enough. The shell of a boiler of this length is seldom made of one sheet, it is made of two or three. It is therefore almost impossible to figure the heating surface theretically correct, but in showing how it is done it ought to be *shown* theoretically correct.

My object is not so much to criticise this lecture as to show the need of a standard rule from which to compute the heating surface of a boiler in practice.

* * *

## THE DESIGNING AND CONSTRUCTION OF MODERN STEAM ENGINES.—9.

THEO. F. SCHEFFLER, JR.

### SHAFT AND FLY-WHEEL CALCULATION.

In order to determine the proper diameter of shaft, it will first be necessary to figure the weight of fly-wheel or pulley, as the case may be. In this particular case we will assume the wheel to be a band wheel. We require a pulley of requisite width of face to transmit 335 horse power to the belt. A heavy double belt having a velocity of 100 feet per minute will transmit .3 of a horse power per inch of width. The diameter of pulley should be 96 inches; the circumference of this pulley is 25.13 feet, and multiplying this by 170, the number of revolutions, gives 4272.1 feet velocity per minute at rim of pulley; this divided by 100 gives 42.7. Therefore 42.7×.3=12.81 horse power for one inch width of belt; and dividing 335 by 12.81 gives 26.15 inches for width of belt; to this add ½ inch, making 26.65 inches for total width of pulley. In calculating diameter of a pulley or fly-wheel, care should be taken to keep within the limit of rim velocity; 80 to 90 feet velocity per second is perfectly safe; in this case the velocity is but 71.2 feet. Having determined upon the proper diameter of pulley, we will proceed with figuring weight, using the following formula:

Let W=weight of rim in pounds per horse power.
" D=diameter of wheel in feet.
" R=revolutions per minute.
" C=co-efficient:

| | |
|---|---|
| Cable railway and rolling-mill engines | =6,500,000 |
| Electric light engines, | =5,500,000 |
| Cotton-mill engines, | =5,000,000 |
| Ordinary engines, | =4 000,000 |

Therefore

$$W = \frac{\frac{C}{D}}{R^2}$$

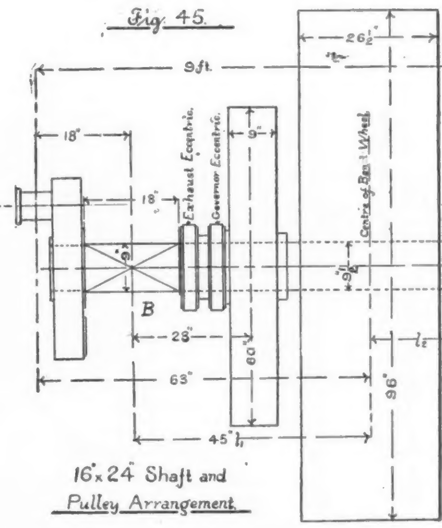
Let D=8.
" R=170.
" C=5,500,000.

Then

$$W = \frac{\frac{5,500,000}{8}}{170^2} = 23.7$$

pounds for weight of pulley rim per horse power; this 23.7 multiplied by 335 gives 7939.5 pounds for total weight of rim. The weight of arms and hub should be ⅓ of rim for ordinary wheels, and ½ for heavy wheels with built arms and hub; we will allow ⅓ in this case. Therefore, 7939÷3=2646 pounds additional weight for wheel, and adding 2646 to 7939 gives 10,585 pounds for total weight of wheel finished, and in the rough about 11,000 pounds; for safety, however, we will make all calculations from weight at 11,000 pounds. We can now proceed with the calculation of shaft, using the following formula:

Fig. 45.




16"×24" Shaft and Pulley Arrangement.

Let $d_{4f}$=the required diameter of the shaft to resist flexure in inches.
" $d_{4t}$=the required diameter of the shaft to resist torsion in in inches.
" $l$=the distance from center of crank-pin to center of journal in inches.
" $l_1$=the distance from center of journal to center of pulley in inches.
" $l_2$=the distance from center of pulley to the center of outend box in inches.
" G=the load upon the shaft in pounds.
" B=the reaction at support B in pounds.
" D=the reaction at support D in pounds.
" H.P.=horse power.
" L=the length of stroke in inches.
" N=the number of strokes per minute.
" J=the diameter of journal in inches.
" $H^1$=the diameter at center of shaft in inches.
" C=the load in pounds at the extremity of the part considered.

$$d_f = \sqrt[3]{806.7\frac{(H.P.)l}{L\,N}} = \text{flexure.}$$

$$d_{4t} = \sqrt[3]{201.73\frac{(H.P.)}{N}} = \text{torsion.}$$

$$B = \frac{G\,l_2}{(l_1+l_2)} \qquad D = \frac{C\,l_1}{(l_1+l_2)}$$

Referring to drawing, Fig. 45 shows the general arrangement of shaft, with location of drive pulley and governor pulley. We will first calculate the flexure of shaft.

Let H. P.=335.
" $l$=18.
" L=24.
" N=340.

Then

$$d_4 \quad 806.7\times\frac{335\times 18}{24\times 340} = 588.89$$

and extracting the cube root $\sqrt[3]{588.89}$=8 38 inches approximately, which is the diameter of shaft where crank-disk fits on. Diameter of shaft for torsion where crank-disc fits on is as follows:

Let H. P.=335.
" N=340.

Then

$$d_{4t}=201.73\times\frac{(335)}{340}=197.69$$

and extracting the cube root $\sqrt[3]{197.69}=5.82$ inches approximately. By comparing the above answers it will be observed that the diameter due to flexure is the greater; and to calculate diameter at journal use the following formula:

$$J=d_{4t}\left\{1+.33\times\left[\frac{d_{4t}^3}{d_{4t}^3}\right]^2\right\}$$

Let $d_{4t}=8.38$.
" $d_{4t}^3=5.82^3=197.69$.
" $d_{4t}^3=8.38^3=588.89$.

Then $$J=8.38\times\left\{1+.33\times\left[\frac{197.69}{588.89}\right]^2\right\}=8.681$$

inches diameter at journal.

We will now calculate diameter at center of shaft with weight of pulley on shaft. First figure reaction at B (Fig. 45).

Let $G=11{,}000$ pounds.
" $l_2=28$.
" $l_1=45$.

Then $$B=\frac{11000\times28}{73}=4219 \text{ pounds.}$$

$$d_{4t}=\sqrt[3]{.002037\times C\times l_1} \text{ for center of shaft.}$$

Let $C=4219$.
" $l_1=45$.

Then $d_{4t}=.002037\times4219\times45=386.64$, and extracting cube root $\sqrt[3]{386.64}=7.28$ inches approximately; and by comparing with cube of flexure at journal, 588.89, we find the answer just obtained small for center of shaft, so that it will be wise to figure diameter, using same formula that we used for diameter at journal, only substituting 386.64, as follows:

$$H^1=8.681\times\left\{1+.33\left[\frac{197.69}{386.64}\right]^2\right\}=9.41$$

inches diameter. This shaft in practice would therefore be called 9½ inches diameter between journals and 9 inches at journals, which will be perfectly safe.

Reaction at D, using previous formula, will be:

$$D=\frac{11000\times45}{73}=6780 \text{ pounds.}$$

Reaction of governor pulley at B will be about 1360 pounds, and adding to the 4219 gives a total of 5579 pounds; this was not calculated with large pulley in figuring diameter of shaft on account of having no stress at periphery of pulley rim, as in the case of large pulley. We will now calculate the shaft deflection from the following formula:

Let W = load in tons.
" $l_1$ = longer distance in inches from center of one bearing to the center of fly-wheel or pulley.
" $l_2$ = the shorter distance in inches from center of one bearing to center of fly-wheel.
" E = coefficient of elasticity; for wrought iron 12,500, and for steel 15,000.
" D = deflection in inches.
" $d$ = diameter of shaft.
" $l$ = length of shaft in inches measured from the center of one bearing to center of the other.

Therefore, $$D=\frac{64\times W\times l_1^2\times l_2^2}{9.42\times E\times d^4\times l}$$

The weight of pulley is 11,000 pounds approximately; some allowance should be made for weight of governor pulley and appendages; this we will assume to be 2000 pounds, making a total of 13,000 pounds. Of course this weight does not all come at one point on the shaft, but for the sake of saving complication in figuring, it is best and safest to figure the total weight at one point.

Let $W=6.5$.
" $l_1=45$.
" $l_2=28$.
" $E=12{,}500$.
" $d=9\frac{1}{2}$.
" $l=73$.

Then $$D=\frac{64\times6.5\times45^2\times28^2}{9.42\times12{,}500\times9.5^4\times73}=.0094$$

inches deflection of shaft. We will now calculate horse power absorbed by friction at journals from the following formula, and as though the shaft was supported in but one journal to save complication:

Let H = the horse power absorbed.
" W = the load or pressure in pounds.
" S = revolutions per minute.
Let $d$ = diameter of shaft at journal.
" $f$ = coefficient of friction.

Then $$H=\frac{f\times W\times S\times.26\times d}{33{,}000}$$

Let W = 15,500 pounds including weight of shaft and crank-disc.
" S = 170,
" $d=9$.
" $f=.035$ for perfect lubrication of journals.

Therefore, $$H=\frac{.035\times15{,}500\times170\times.26\times9}{33{,}000}=6.5 \text{ H. P.}$$

Per centum of power will be

$$\frac{6.5\times100}{335}=1.9$$

per cent. of total power absorbed by friction. This horse power absorbed by friction of shaft in journals is likely to be reduced at crank end of shaft by the upward thrust of shaft on pillow-block cap. By referring back to description of main journal, it will be noticed we have a pressure of 4251.2 pounds on pillow-block cap, caused by angularity of connecting-rod when the crank is turning over. This pressure will, of course, to a certain extent counterbalance the downward pressure of 15,500 pounds (that is, assuming that all pressure is on one journal, as we have calculated the friction); we have the pressure of 15,500 pounds, but it is not distributed equally on both journals, which will be noticed by referring to reaction at journals. If we divide 4251.2 by 15,500 we obtain the percentage of reduction of horse power absorbed by friction of shaft, which gives .27 per cent., and multiplying $6.5\times.27=1.75$ horse power less for friction, and subtracting we have $6.5-1.75=4.75$ horse power aborbed by friction of both journals approximately; but in summing up total friction it will be advisable to retain the 6.5 horse power and allow the 1.75 horse power as being so much for a factor of safety.

* * *

## NOTES FROM NOTOWN.

Whenever I hear men kicking about a few letters, a square root sign and straight line, commonly called a formula, it recalls my own experience with a small bored one, and how the boss showed me what a fool I was for throwing the paper down without tacking it, for 'twas something I had been asking him about that very day. We were talking about shafting, and when he happened to remark that a 4-inch shaft would weigh four times as much as a 2-inch shaft, I dropped the hammer on the floor and looked at him. Then I happened to pick up a paper that noon which had this in it: "Weight of an iron shaft $=d^2\times.7854\times.28$, $d$=diameter of shaft." This was just what I wanted, but what did those idiotic letters and figures mean? After looking at it three seconds and a half I fired it under the bench and went to play cards with the boys. Boss saw me, and that night he said: "Ike, I don't like to say it, but you're an idiot to give up such a simple thing and go off without learning what that meant." "But I'm no algebra-ra-rion, or whatever you call it," said I; "those letters and things don't mean anything to me; they're for scholars and bosses." "Ike, what do you take that paper for, for fun or to learn something?" "Why, to learn, I suppose, but"— "No buts; you didn't believe me about that shaft this morning; to-morrow we'll prove it by weight, but to-night we'll tackle that formula and see why it is so. In the first place let's see if you really know what .7854 is. Don't, eh. Well, it's a 'constant,' or a number which shows the relation of the area of a circle of any diameter to a square of the same diameter. If a square plate of iron weighs 10,000 pounds, then the largest circle that can be cut from this will weigh 7,854 pounds. Don't believe that either, eh, or don't see how I know? Well, come into the druggist's. Now here's a card 4 inches square and it weighs—let's see, 100 grains. Now we cut a 4 inch circle out of it and that weighs about 78½ grains, near enough in our rough experiment to show what I mean. Now, you can put this down as a *fact*, that a circle contains

$$\frac{7{,}854}{10{,}000}$$

or .7854 the area of a square of the same diameter. Here is a card 8 inches square, which weighs 400 grains; cut a circle out of this and it will weigh 314 grains, or four times the weight of the 4 inch circle, just as the 8 inch square weighs four times as much as the 4 inch square; so you see, Ike, the weight varies as the square of the diameter. Don't quite see that? Well then, 4×4

$=16$ and $8\times 8=64$, 64 divided by $16=4$, showing that the area is four times in this case, because 8 inches is twice 4 inches, and 2 squared $= 2\times 2 = 4$. You can also put it down that the areas of similar figures vary as the *square* of their similar dimensions. Thus a 2 inch circle contains $2\times 2\times .7854 = 3.1416$ square inches, while a 6-inch circle contains $6\times 6\times .7854 = 28.3744$ square inches, or 9 times as much, which we can find by saying 6 equals 3 times 2 and 3 squared equals 9, so the area must be 9 times as great. D equals diameter of shaft, then $d^2$ means diameter squared or multiplied by itself. Take a 2 inch shaft: $2\times 2=4$, $4\times .7854 = 3.1416\times .28 = 879+$ pounds per inch of length. Why do we use .28? Because one cubic inch of wrought iron weighs $\frac{28}{100}$ of a pound, and that makes this a 'constant' also. Any number which we use in this way, as the weight of a gallon of water, a cubic inch of iron, or the foot-pounds in a horse power is a constant. These are found by experiment and accepted as correct, after being proved in this way; we know that the circumference of a circle is 3.1416 times the diameter, regardless of the diameter, it being found by accurate measurement and can be verified by careful experiment. But to resume. Take a 4 inch shaft and see what it weighs per inch. $4\times 4=16$, $16\times .7854 = 12.5664\times .28 = 3.516+$ pounds per inch. We'll prove this to-morrow. Now right here let's see what we learn about the relation of diameters and weights. Squaring the diameter of the 2 inch shaft we get 4, and with the 4 inch shaft we get 16, or four times the square of 2, then without going further we know that it will weigh four times as much, as *areas vary as the square of the diameter*. Now, Ike, think this over and if you don't see it tell me, but work at it till you do, and don't be afraid of a few letters till you try and see if you can't find what they mean, for its so much handier than using a whole string of words which wouldn't tell any more, after you know how to read formulas. Good night, Ike; study it out." Well, I did, and when I got home I tackled another one, which may be of interest. Weight of iron plates per square foot = thickness in eighths $\times$ 5. Iron $\frac{5}{16}$ inch thick, 2 by 3 feet, what is the weight? Then $\frac{5}{16}=2\frac{1}{2}$ *eighths*, $2\frac{1}{2}\times 5 = 12\frac{1}{2}$ pounds per square foot, $2\times 3$ 6 square feet, $6\times 12\frac{1}{2} = 75$ pounds as weight of plate; it's a very simple affair, but it is a handy one, and many others are just as simple.

ICHABOD PODUNK.

* * *

## WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

### FACE AND WEAR OF GEAR WHEELS.

Quite frequently the writer has come across articles on gear-wheels and the strength of same, which usually differ only in the author supposing the load taken by one or more teeth, but never any thought being given to the width or face required to transmit a certain horse power to prevent rapid or excessive wear. Usually the face is taken two and one-half times the pitch. This, when figuring for strength only, would do very well for crane gearing where the average load is probably less than one-half the maximum load. For continuous transmission, however, the face should be made wider, the width of face to be governed by pressure and number of revolutions, for reasons which will appear quite obvious from the following.

As an example: If a machinist takes a file and with a pressure of say 5 pounds upon it, draw it over a piece of metal twenty times a minute, a certain amount of metal will be worn away; if now he double the pressure, that is 10 pounds, and make the same number of strokes per minute as before, then within certain limits double the first amount of metal will be worn away in the same time. Now, instead of doubling the pressure the same result might have been obtained by making twice as many strokes and using a pressure of 5 pounds as in the first case. From this it will be seen that by increasing either the pressure or number of strokes per minute in the same proportion, like results are obtained. Also that pressure = P multiplied by number of strokes per minute = $n$, will be alike in all cases where the amount of metal removed is the same. As for instance, when $P=10$ and $n=20$. Then $10\times 20=200$ when $P=5$ and $n=40$, $5\times 40 = 200$ In the case of gear wheels pressure on teeth corresponds to pressure on file and number of revolutions to strokes per minute, and as it is a fact that when desiring to transmit a certain horse power at different velocities, keeping the diameter of the wheel the same, P "must be decreased in the same proportion as $n$" is increased, or vice versa, and as $P\times n$ is a constant quantity for that horse power and diameter, it follows that the same amount of metal will be worn away per minute no matter how much the velocities may differ, and consequently the face of wheel must be kept the same for all velocities if the same wear is to take place. All that remains now to be determined is this constant $P\times n$, which must not be exceeded per inch of face of wheel. Prof. Reuleaux, in his "Constructor," recommends that $P\times n$ be not taken greater than 28,000 per inch of face for cast iron gears; this being deduced from observations of wheels that gave good satisfaction as to wear. He also states that in some cases this quantity was as high as 70,000, but where this was exceeded rapid wear took place. The writer knows very well that with high velocity

$$\frac{P\times n}{b} = 28,000$$

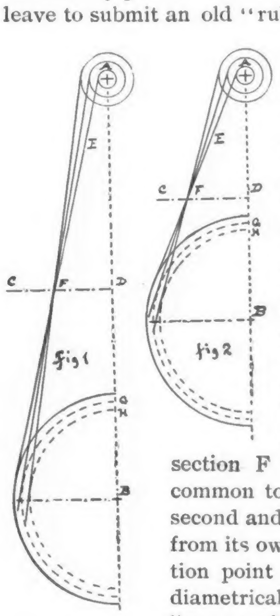
(in which $b$ = width of face) gives a very wide face for large powers, when compared with the face given by the usual rules; but even if one has to compromise somewhat and use a higher constant, one can see immediately what wear he may expect, which no rule, that gives the strength of teeth only and fixes the width at two and one-half times pitch, shows. To show that rules, as for instance the one by Mr. Samuel Webber given in the March number of MACHINERY, H. P. $= 5\times$ velocity $\times t^2$ do not provide for wear, it may easily be figured that if a certain horse power were to be transmitted, diameter of wheels being alike, a wheel at a certain velocity would have say 10 inch face; at double that velocity 7.07 inch face, and at three times the velocity 5.77 inch face; from which follows that the last wheel, with 5.77 inch face, would wear nearly twice as fast as the one with 10 inch face.

Having taken up considerable space already, I shall not give any rules for calculating for strength of teeth, but reserve same for some future article.

Pittsburgh, Pa. JOHN L. KLINDWORTH.

### MORE ABOUT CONE PULLEYS.

Mr. Cheney's article on "Cone Pulleys and Belts" in the April number of MACHINERY is readable, practical and good, from the scientific standpoint; but in these days of hurry and rush, is not the simplest and most practical "get there" plan the cheapest and best for the men who actually have the proportioning of cone pulleys and belts to do and be responsible for? With the hope that it may prove to be of benefit to some of your readers, I beg leave to submit an old "rule-of-thumb" formula, or plan, which many years of use has proved to be too nearly accurate to be "sneezed at," and does away with all "figuring," which the average mechanic avoids wherever he can, as you well know.



Having determined the diameter of one cone pulley, say a three-step cone A and *one* diameter of its mate, lay out both on the drawing board, spacing off the center line A B with the cone centers the proper distance apart. At *right angles* with A B midway between the center points, draw the line C D, then draw belt line E from cone to cone on its proper step or diameter. The point of intersection F with line C D is practically a point common to each shift of belt. If, therefore, the second and third belt lines are also drawn, each from its own cone step and through the intersection point F, it only remains to sketch in the diametrical lines G and H, each to its own belt line, to show the necessary diameters of the remaining steps of the second cone pulley. It will be seen at once also, by comparing Figs. 1 and 2, that the farther apart the cones are placed, the greater the "drop" on the second cone becomes, and also in the case of cones of different diameters, that if the drop is an uniform one on one cone, it will not be on

the other, in order to carry a tight belt on all speeds, as is shown clearly, I think, on my hastily drawn sketch.

I trust that this simple rule may be of as much service to others as it has often proved to me.

Newark, N. J. EDWARD O. CHASE.

PRESSURE ON GUIDES.

Answering a query about the formula for finding thrust on crosshead slides, would say this requires a lengthy analysis, and can be better understood by a thorough study of triangulation of forces; the writer will, however, give his own reasons as he understands the term of the formula. The pressure multiplied by the stroke gives the total number of inch pounds for one stroke; this is, of course, assuming that there is pressure on the piston the whole length of stroke, which is the way it should be calculated. Then the total length of connecting-rod must be considered, as it depends very much on the length what the ultimate result will be. The longer the rod the less will be the thrust on the slides We multiply by 4 because we have squared the length of rod as well as the stroke in inches, and we square the length because for one revolution we have two strokes and consequently two vibrations of the connecting-rod for one revolution, and the same reason is given for squaring the stroke in inches, and for this reason we must deduct the square of the stroke from the square of the length, because we have already multiplied the pressure by the stroke in inches; consequently for the above reason we must extract the square root to bring the division back to the original standing before we had squared the length of rod and stroke. The writer has given these reasons for the arrangement of formula, but as he is not the originator of same can only give them to the best of his judgment. The above formula used for calculating thrust on slides has proved to be correct in every particular case when the writer has used it.

Erie, Pa., THEO. F. SCHEFFLER, JR.

STEAM VS. GAS ENGINES.

After numerous articles in technical papers in France and England answering the comparison, gas vs. steam engines, I will now resume the debate.

At the practical point of view, variations of load, etc, it is my opinion that the steam engine still holds a very fine place.

Only speaking of a sensible loss in the case of gas engines, it will be sufficient to name the loss of mechanical efficiency, owing to the great amount of power absorbed by the gas engine mechanism, and the indicated horse power thus absorbed greatly affects the effective horse power when the engine does not run with its full load.

Concerning the consumption of fuel, M. Aimé Witz, in his letter of April 12, in *Le Genie Civel*, shows that the advantage rests with the steam engine, for Mr. Delamare Boutteville (*Genie Civel* of April 6, 1895) makes use of coal at 20.00 francs per ton, while I am using coal at 13.90 francs per ton delivered at Brussels.

Taking M. Aimé Witz's calculations we find:

600 grammes of coal at 20.00 francs................ 0.0120 francs for gas engine.
714 " " 13.90 " ................ 0.0099 " " steam engine.

That is to say 20 per cent. in favor of steam, without taking the natural advantages of steam engines into account.

It should not be lost sight of that we based our calculations on an evaporation of 8 pounds of steam per 1 pound of coal, and we beg to say that in a convenient boiler plant this evaporation is generally surpassed.

I thank you very much for having opened your columns to the discussion of this very interesting subject.

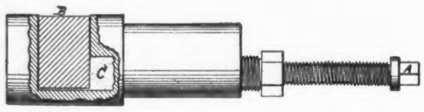
Brussels, Belgium. ARTHUR BOLLINCKX.

A PERFECT SCREW.

In discussing with Mr. T. R. Almond the problem of producing a perfect screw, he proposed a method which the writer is sure will be new to the majority of mechanics, although it may possibly have been suggested before. The idea is to take a steel rod of suitable diameter and ground true, and coil wire around it the same as winding a close spring, *i. e.*, each coil touching its neighbor, and use the thread thus formed to cut a true screw with. This gives a thread which will not do for constant wear, but which will surely be sufficient to cut one screw, or to finish and true up a screw roughed out on another lathe. As wire can be had which is almost absolutely uniform, the plan seems perfectly feasible, and is at least worth a thorough trial, unless it has been tested and found wanting, and if so it would be interesting to know of the results obtained. The greatest difficulty would seem to be in starting the coil absolutely true, for the size of wire is not important providing it is uniform. C.

A HANDY TOOL.

Here is a sketch of a simple and useful displacement tool used in the Fall Brook shops at Corning, N. Y., for removing piston-rods from crossheads of the Laird type. Any one who has had any experience in driving wedges in on top of an aggregation of nuts, washers, etc., and having the whole mess tumble down a few times without breaking the fit, can appreciate it. The pin in front end of main rod is removed and this device is put in with the small piston B in line with the piston-rod end and a small block with a handle like a mallet is used to fill the intervening space. A few turns of the screw A forces out the little piston and separates the piston-rod from crosshead by the exertion of a surprising small amount of power. Tallow is the material used for filling. The same principle, with some changes in form, is used in a tool for removing frame-bolts, small crank-pins, etc. One man with a two-foot wrench on screw has exerted a force or sixty tons by actual test.




Corning, N. Y. F. E. R.

* * *

## MANUFACTURING NOTES.

THE LINK-BELT MACHINERY Co., Chicago, are now busily engaged building 3,000 H. P. Standard Water Tube Safety Boilers for the North Chicago Street Railway Co.'s new power plant at Hawthorne avenue and Hobbie street.

THE BUFFALO ENGINE WORKS, Buffalo, N. Y., is a new concern composed of several well known mechanics of that city, who will engage in the manufacture of marine and stationary engines and other specialties. They have contracted with the Lodge & Davis Machine Tool Co., of Cincinnati, O., for the entire equipment of their plant, including several large lathes, planers, drill presses, shapers, etc.

ON June 1st the Cleveland Twist Drill Co. will remove from their present quarters, No. 102 Reade street, to No. 99 Reade street, New York city where they will place in charge of Mr. C. I. Markham, a new and complete stock of their twist drills and tools, together with complete samples of their manufactures.

THE "limited" trains of the New York Central are models of speed and elegance.

* * *

## FRESH FROM THE PRESS.

"NYSTROM'S POCKET BOOK" is well known to engineers and mechanics, and its twenty-first edition, revised by Mr. Robert Grimshaw, brings it up to date as a book of reference. It is neatly bound in pocket-book form, and contains about 700 pages devoted to engineering subjects, together with notes and data by its revisers, with the authority for changes made. As an example, the weight of a cubic foot of water under standard conditions is now determined as 62.291 lbs., instead of 62.5 as before. It is published by J. B. Lippincott & Co., 715 Market street, Philadelphia, Pa. Price, $3.50.

THE MECHANICAL ENGINEERS' POCKET BOOK. William Kent, A. M. M. E. John Wiley & Sons, 53 East 10 street, New York. 12 mo. morocco flap. $5.00. The author has given us a book of reference of which he may well be proud, and one which should be a favorite with mechanics generally. He has departed somewhat from the usual methods and does not assume to be an authority on all the subjects treated, but gives the source of information where possible. Much attention has been paid to data of experiments from recent literature and many periodicals quoted. It is impossible to do justice to the book in a brief review, but the mechanic in almost any line will find it a mine of information worth many times the price. The data collected regarding machine shop practice is invaluable to any man who wishes to be abreast of the times, and the same might be said of other portions of the book. Its coming should be welcomed as a valuable addition to engineering literature.

THE 1895 catalog of the EAGLE LUBRICATOR Co., 106 Canal street, Cleveland, O., shows the variety of engine and boiler-room appliances made by them. Their sight-feed lubricator is shown in several styles, while the Globe Automatic Injector receives attention, with rules for placing, size of pipes, capacity, etc. The Globe ejector, gauge cocks, water glasses and flue cleaners made by them are also described.

POWER TRANSMISSION FOR MACHINERY is the title of a new catalog by the Link-Belt Machinery Co., of Chicago, and the Link-Belt Engineering Co., of Philadelphia, showing, mostly by half-tones, the works and products of these companies. Friction gearing receives attention, as well as leather belting and rope drives, giving considerable information on the subject.

THE UNION GREASE Co., Boston, Mass., have issued a new catalog setting forth the merits of their lubricating and rust preventing mixtures, which have been well known for years.

THE DODGE CALCULATOR is the latest production of the advertising department of the Dodge Mfg. Co., Mishawaka, Ind. It is composed of two graduated cardboard disks, which, on being set correctly, show at a glance the revolutions of driving and driven shafts and the diameter of pulleys necessary to secure any desired speeds. We believe they are sent on application.

MESSRS. RAWSON & MORRISON, Cambridgeport, Mass., send us their latest catalog of the various hoisting, handling and compressing machinery, operated by steam, hydraulic and electric power, and applied to various purposes as means of saving much time and labor.

COL. ALBERT A. POPE keeps at the "good roads" problem with a praiseworthy persistence, the latest move being the distribution of a circular letter regarding the State roads in Massachusetts, their aim and accomplishment. All wheelmen should aid him in the work which means so much to them.

# Which do you prefer? ❊ ❊ ❊

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To do without a steam separator and pay constantly increased coal and repair bills. . . . . . . . .

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To pay for a modern separator, avoid waste of fuel and possibility of breakage of engine. . . . . . . .

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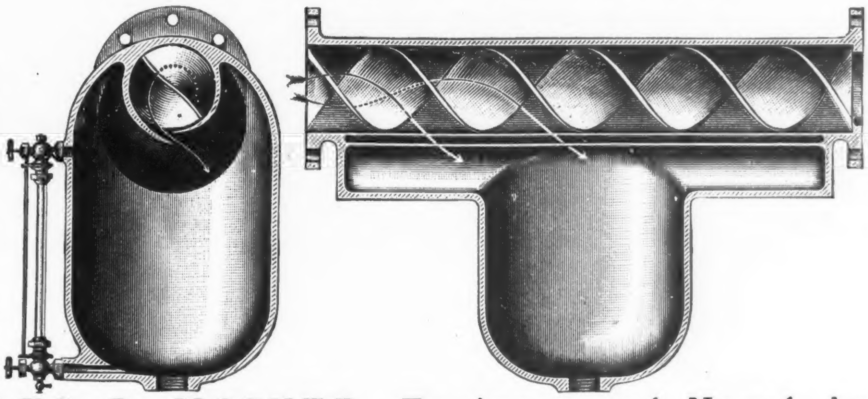

IF NOT, my catalogue "F," containing treatise on the steam separator will tell you in very plain language.
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CHARLES D. MOSHER, Engineer and Naval Architect,
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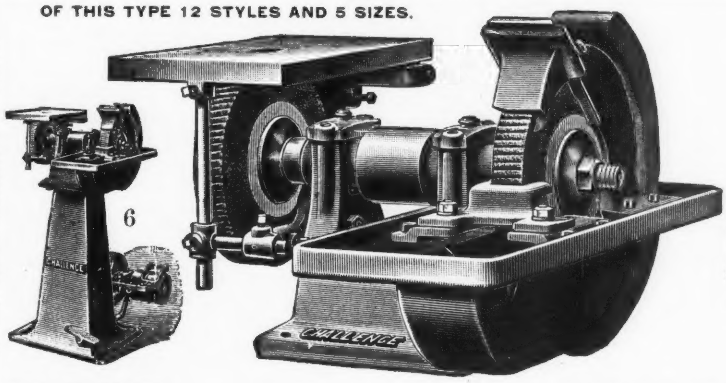


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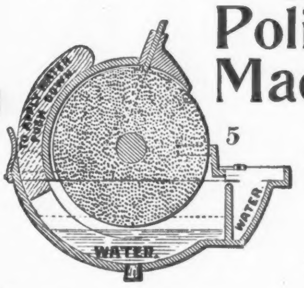


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CONSULT THE INDEX ON PAGE 5

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2. **Compound Engines.** A. Mallet, revised by R. H. Buell, C. E. 50 cents. Treats the subject quite clearly, but contains considerable mathematics, which will be appreciated by designers. Sent, post paid, for two new subscribers, or the book and one subscription for 70 cents.

3. **A Treatise on Fuel.** Arthur V. Abbot, C. E. 50 cents. A very good book for those fairly familiar with mathematics, but is not a "popular" treatise. Sent, post paid, for two new subscribers, or the book and one subscription for 70 cents.

4. **Safety Valves.** R. H. Buell, C. E. 50 cents. A good book for engineers, firemen and others interested in boilers. Sent, post paid, for two new subscribers, or the book and one subscription for 70 cents.

5. **Teeth of Gear Wheels.** Prof. S. W. Robinson. 50 cents. A clear and practical treatise for those who deal with gears, such as pattern-makers, machinists, etc. Sent, post paid, for two new subscribers, or the book and one subscription for 70 cents.

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7. **Strength of Materials,** by William Kent, C. E. 50 cents. Contains tables and much information useful to designers generally. Sent, post paid, for two new subscribers, or the book and one subscription for 70 cents.

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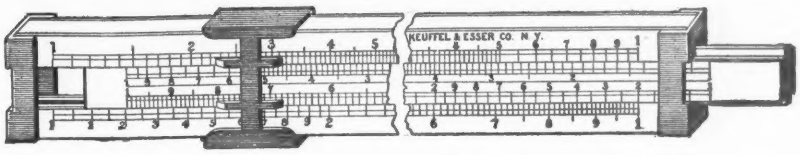


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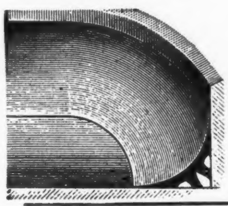

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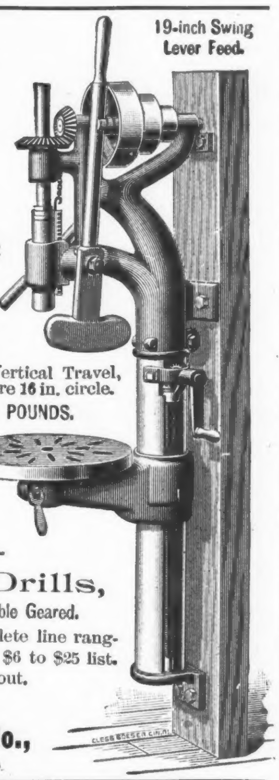

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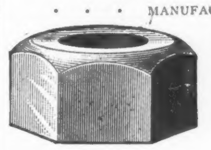

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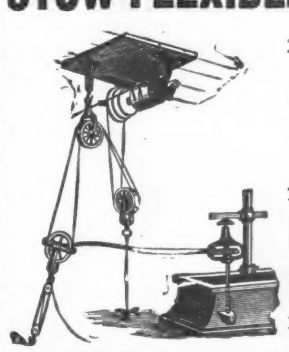

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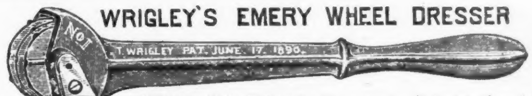



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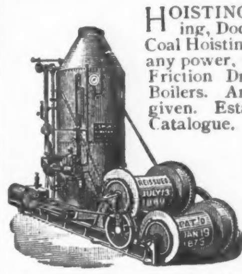

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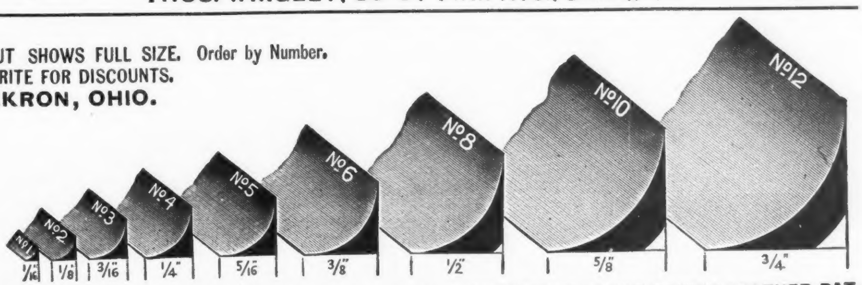


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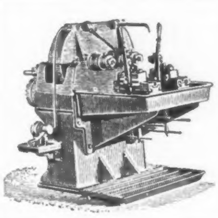

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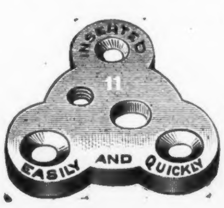


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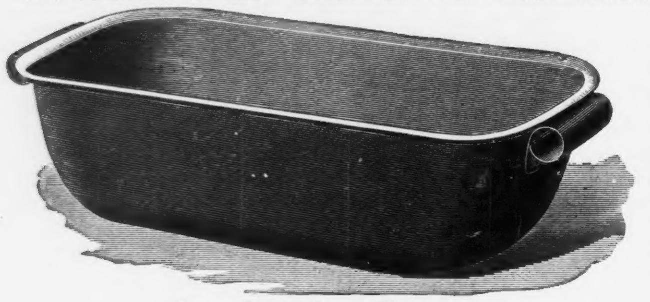

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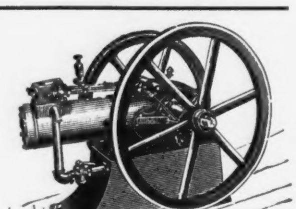

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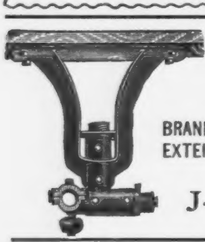

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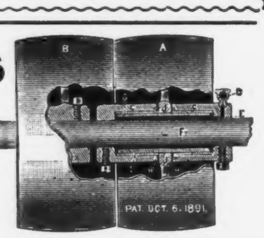


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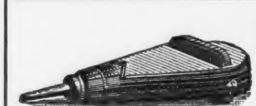

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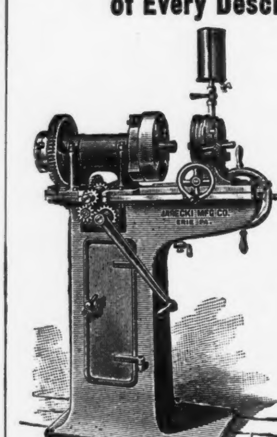

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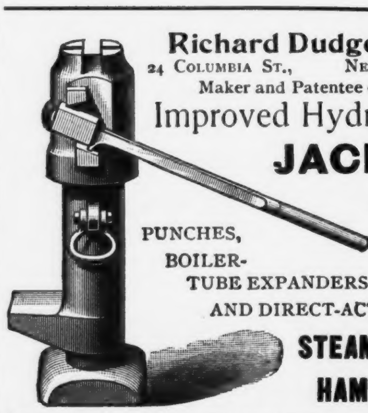

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